MARINE ALGÆ OF BEAUFORT, N. C., AND ADJACENT REGIONS : : : : : By W. D. Hoyt

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FOREWORD.

The accompanying report by Prof. W. D. Hoyt is one of a series relating to the aquatic resources of the region adjacent to the biological station of the Bureau of Fisheries at Beaufort, N. C. This work comprises a scientific account of the marine algæ, commonly known as seaweeds, and is based on prolonged studies at the Beaufort station. The report is necessarily technical, but the author has endeavored to make it generally useful and has made the identification of the species clear by means of illustrations and simple keys. The result is a serviceable handbook for those who, for one reason or another, have occasion to identify the seaweeds.

The question may be asked, Why should the Bureau of Fisheries be interested in marine algæ? Excluding purely scientific considerations, there may be recalled the well-known fact that all animals depend on plants for food, and this is as true of water animals as of land animals. It matters not if a particular fish confines its diet to smaller fish or other animals rather than to plants. These smaller forms must feed upon something. At the end of the chain in every case there are plants of one kind or another, all engaged as busy little factories for the manufacture of food for fishes out of the inorganic materials which are otherwise useless or unavailable to fish. If we value fish and shellfish, we must be interested in the sources of their food; that is to say, in the seaweeds as well as in the innumerable minute plants of the sea and its bottom which do not come within the scope of this report.

It should not be overlooked that seaweeds have a direct economic importance. On other parts of the United States coasts, and more particularly in other countries, algæ are used in the natural state as food or as the basis for the preparation of food articles, such as gelatins. They constitute the raw materials from which are derived valuable commercial products, such as agar-agar, essential in bacteriological work; iodine, one of the most useful of all medical bases; and potash, a highly prized fertilizer.

The present report could not enter into a discussion of these economic relations, but it contributes the foundation of knowledge as to what the waters of the South Atlantic coast have in the way of algæ. It has been the labor of years, and, while the cost to the Government has been nominal, the results are of permanent value, especially in view of the fact that the algæ of the region have remained almost unknown.

It has not been possible for the author to consult every publication cited, and he has not had access to the type specimens of many of the species. Additional species will undoubtedly be found from time to time. These considerations, however, do not detract from the importance of the work.

H. M. Smith,
Commissioner of Fisheries.

CONTENTS.

MARINE ALGÆ OF BEAUFORT, N. C., AND ADJACENT REGIONS.

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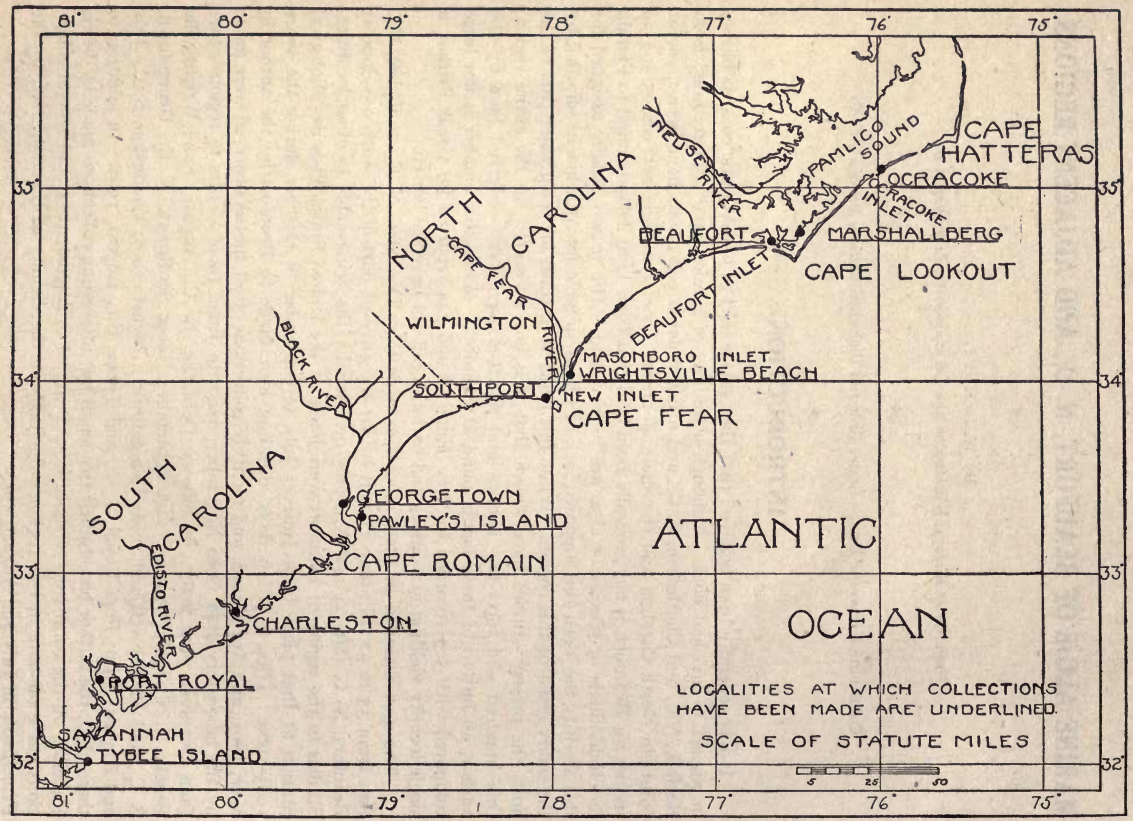
Contribution from the United States Fisheries Biological Station, Beaufort, N. C.

INTRODUCTION.

It has generally been believed that the greater part of our Atlantic coast is barren in respect to an algal flora. Although a number of species have been recorded from Norfolk, Va., and Charleston, S. C., and a few isolated collections have been made at points in North Carolina and elsewhere, Johnson (1900) recording between 25 and 30 species for Beaufort, it has generally been held that from Long Island Sound to Florida few individuals or species of algæ are to be found. The reason usually assigned for this sterility has been the supposed lack of places suitable for attachment afforded by the sandy coast of this region. While this belief is justified for the greater part of the area, the present studies have shown that it is not warranted for the entire region. One hundred and forty-two species and varieties have been observed here by the author, all but 10 of these being found at Beaufort. While this number is not large compared with 525 recorded for New England and 744 reported for Great Britain, a single locality yielding 132 species and varieties can not be called barren.

The area included in these studies extends from Ocracoke, N. C., to Tybee, Ga. (lat. from 35 to 32° N., map 1), but by far the greatest part of the work was done at Beaufort, N. C. (lat. 34° 43′ N.), only occasional visits being made to other localities. Studies in the region of Beaufort were made at the United States Fisheries Biological Station at that place from June or July to September or October during the years 1903–1909. Trips of a few days' duration were made to Beaufort by the author in May, 1907, and April, 1908, and monthly collections of all species observed were made by the laboratory staff from November, 1908, to June, 1909. Visits to regions other than Beaufort were made, as follows: Ocracoke, N. C., August, 1907; Wrightsville Beach, N. C., July, August, and September, 1909; Southport, N. C., Georgetown, S. C., and Pawley's Island (near Georgetown), August, 1909; Charleston, S. C., July and August, 1909; Port Royal, S. C., and Tybee, Ga., August, 1909. In addition to these algæ, the author has studied two small but interesting collections made by Lewis Radcliffe on the coral reefs offshore from Beaufort in August, 1914, and several collections made offshore in this region, principally in the vicinity of the coral reef, by the *Fish Hawk*, in July and August, 1915.



MAP 1.—Region included in these studies, showing localities at which collections were made. (The locations of Masonboro Inlet and Wrightsville Beach should be reversed on the map. The collections in this place were made in Banks Channel, just south of Moores Inlet, about 1.5 miles north of Masonboro Inlet.)

In the preparation of the present report three objects have been kept in view: (1) Only occasional collections have previously been made on the coast of our southern States. While the algal flora of New England and Long Island has been studied with some thoroughness and the Florida coast has received considerable attention, the area between these regions has been almost untouched in recent years. Although the present work makes no pretense of being a taxonomic contribution, the effort has been made to present as complete an account as possible of the algal flora of the region, with remarks on species affording interesting comparisons with the same species found in other regions. (2) Little is known of the conditions of algal growth and of the factors limiting their distribution in space and in time. Notes have been made on the conditions observed at Beaufort, and some interesting effects of these conditions have been recorded. It would be desirable to have a detailed and thorough study of the conditions made here. (3) No work suitable for American collectors who are not trained students of algæ has appeared in recent years, and no such work has ever been written for the algæ of our southern coast. Although this lack has been partly filled by Collins's excellent treatment of the Chlorophyceæ (1909, 1912, 1918) and key (1918a) and Miss Tilden's work on the Myxophyceæ of North America (1910), the need still exists for a special account of the algæ of this region. With this object in mind, the present report has been written as simply as possible. Technical terms have been avoided whenever the meaning could be expressed otherwise without too great circumlocution and without sacrifice of accuracy. Nearly every species has been illustrated by a photograph or drawing, since an illustration will often give, to one not a special student of the algæ and even to the trained algologist, a better idea of the species than pages of description. Two keys have been prepared, one (an artificial key to genera) based as far as possible on superficial, easily observed characters, the other (a natural key to divisions, orders, etc.) showing the diagnostic characters which warrant the placing of the different forms in their respective groups.

All photographs and, except where otherwise stated, all drawings are original, nearly all the photographs being made from living plants and all the drawings being made with a camera lucida. In the descriptions of the various groups and in the natural key free use has been made of current works, especially those of Engler and Prantl (1897–1911), De Toni (1889–1907), and Collins (1909, 1912). The descriptions of the species, however, are based in part on specimens observed by the author, including those found at Beaufort and those in American herbaria which were accessible to him. In using the artificial key to genera and the keys to species, it should be borne in mind that these have been prepared for the particular genera and species mentioned in this work, and if used for algæ of other regions may lead the student astray. Even in this region these keys may cause confusion if genera and species other than those mentioned should be found. A collector should, therefore, always carefully compare his specimens with the descriptions before venturing to assign them names. The gross measurements of the size of species should not be taken too strictly, the figures given being the limits of specimens observed by the author or for which a record has been seen.

It will be noticed that the descriptions of many of the species are incomplete in that no mention is made of male plants or organs. This is due to our imperfect knowledge of these plants, since, partly because of their inconspicuousness and partly because of their greater scarcity, male plants and organs have been studied much less

than have the other forms of plants and organs of reproduction. Svedelius (1908, 1912) has shown that, in Martensia and *Delesseria sanguinea*, the male plants have an exceedingly short duration, in the latter species not more than one month. Miss Dunn (1917) has called attention to the fact that, in *Dumontia filiformis* on the coast of Maine, the male plants are found only during a few weeks in the spring. A similar scarcity of male plants has been observed by the author for many species at Beaufort. In spite of extensive searches for them, no male plant of *Gracilaria confervoides* has been observed, and none of *Gracilaria multipartita* has been found in the harbor; only one male plant of Hypnea has been found among the hundreds examined; and male plants of Chondria are rare. Many other instances of the same kind might be given. While further search might show these to be more abundant than is indicated here, it seems to be true that, with the exception of a few species, male plants and organs are much scarcer than are the other forms of plants and organs. Because of this fact, anyone finding male plants or organs of a species in which they are not described in this work, should save these for study, or should send them to some other student of the algæ.

Among the Phæophyceæ and Rhodophyceæ all determinations have, as far as possible, been verified by comparison with type or authentic material. Among the Myxophyceæ the determinations have been made entirely and among the Chlorophyceæ they have been made largely by Mr. Frank S. Collins. Under each species references are given to the original place of publication; to the most recent general account of the algæ, the Sylloge Algarum of De Toni (1889–1907); and to the works of Harvey (1852–1858), Farlow (1882), Collins (1909, 1912, 1918), and Miss Tilden (1910), these being the publications of a more or less general nature dealing with North American algæ. In a few cases other references of special interest are given. Citations are given, also, to the two principal sets of American algæ, the Algæ Americanæ Boreales Exsiccatæ (A. A. B. Ex.) of Farlow, Anderson, and Eaton, and the Phycotheca Boreali-Americana (P. B.-A.) of Collins, Holden, and Setchell. With some exceptions, where the works cited were not available, all references have been verified. The arrangement used follows, in most respects, that of Engler and Prantl (1897–1911),[a] except in the Chlorophyceæ, where Collins (1909, 1912, 1918) has been followed. The system of nomenclature follows the Vienna and Brussels rules except in the naming of the divisions, where Chlorophyceæ, etc., have been used. The retention of these names seems justified by usage, convenience, and uniformity, and, although not yet acted upon by any congress, seems to come under the principles of nomina conservanda.

Those wishing to know more than is given here about the structure of the algæ mentioned should consult Oltmanns (1904–5) and Engler and Prantl (1897–1911), where are summed up the main facts about the structure of algæ known at the time of their publication.

A work of the present nature necessarily has a limited usefulness and should be replaced by an account of the algæ of our entire coast. If the present report contributes toward the preparation of the larger work and serves in the meantime to forward the study of the algæ of our Atlantic coast, it will have served its purpose.

[a] While this arrangement is inconsistent and apparently wrong in many respects, we have not yet sufficient knowledge to warrant a complete revision, and must, accordingly, use it until we obtain more information about the life histories and structures of the various groups of algæ.

The author takes pleasure in acknowledging his indebtedness to those who have helped him in the present study. To Frank S. Collins, North Eastham, Mass., and to Dr. Marshall A. Howe, the New York Botanical Garden, he is especially indebted for assistance in the determination of species given throughout the progress of this work and for much helpful advice and information about the distribution of species and about doubtful points. He is indebted to Dr. N. L. Britton for facilities for studying the algæ in the New York Botanical Garden and for the use of Plates CXV–CXIX, and to other members of the staff of this institution for assistance during his work in the library there. To Prof. W. G. Farlow, Harvard University, he is indebted for assistance in the determination of species and for the privilege of studying the algæ in his herbarium; to Prof. D. S. Johnson, the Johns Hopkins University, for facilities of laboratory and library furnished for the study of the Beaufort algæ; to Mrs. Margaret H. Y. Hoyt, for assistance with the drawings used in this work and with the preparation of the manuscript. To all of these and to others who have helped him in various ways the author wishes to express his grateful appreciation of their assistance.

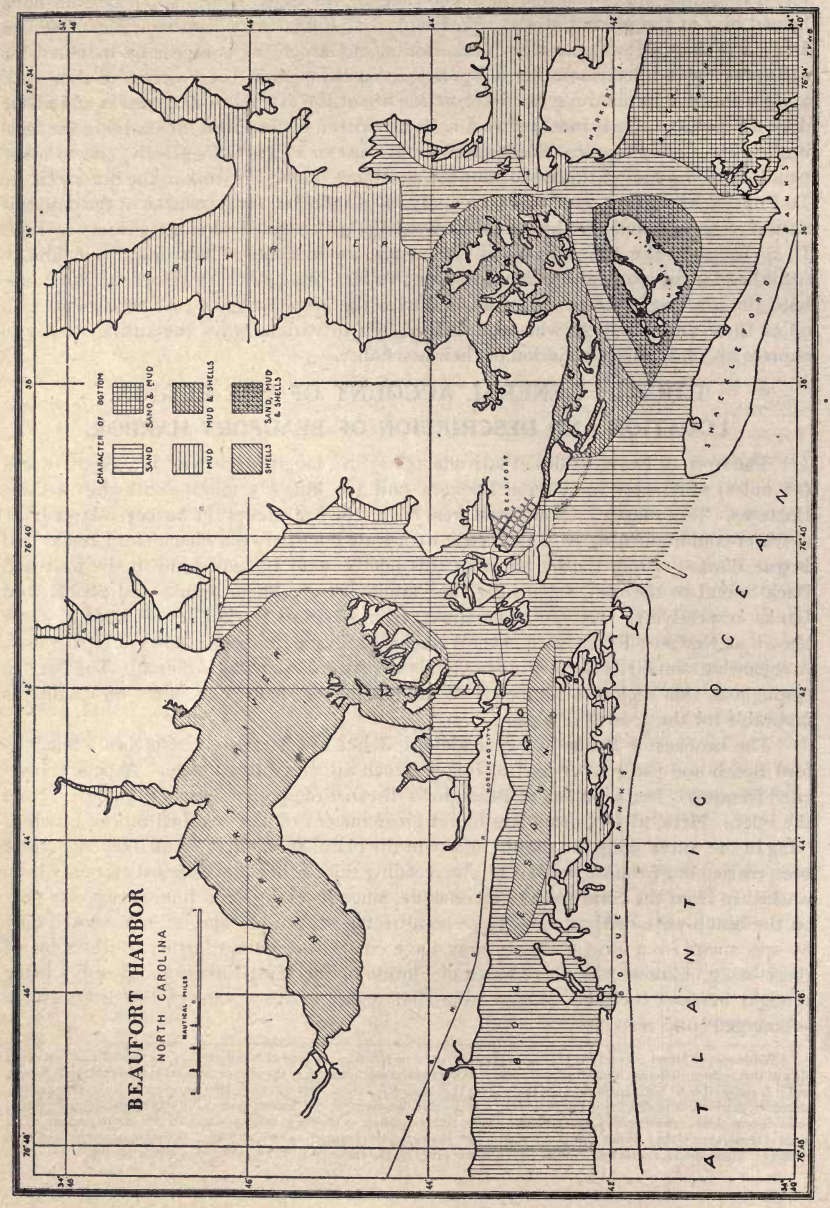
PART I. GENERAL ACCOUNT OF THE REGION.

LOCATION AND DESCRIPTION OF BEAUFORT HARBOR.

The town of Beaufort lies at latitude 34° 43′ N., longitude 76° 40′ W., about 19 km. (12 miles) northwest from Cape Lookout and 120 km. (75 miles) southwest of Cape Hatteras. (See map 2.) South and west of the town stretches the harbor, a large body of water communicating with the ocean by a wide inlet between Shackleford Banks and Bogue Banks. From the harbor near this inlet extend Bogue Sound to the west and Back Sound to the east, separating the mainland from Bogue Banks and Shackleford Banks, respectively. Extending northwest from Beaufort Harbor lies the body of water known as Newport River, with several creeks, receiving frequent inflows of fresh water. A somewhat similar body of water extends northward from Back Sound. The bottom throughout this region is composed of sand, mud, or shells, and offers no conditions favorable for the growth of algæ.

The beaches of Bogue and Shackleford Banks are flat, sandy stretches. Shackleford Beach and the greater part of Bogue Beach are destitute of algæ. Algæ are, however, frequently found on Bogue Beach for a distance of about 1.6 km. (1 mile) west from the inlet. Here, after storms, are found great masses of algæ washed on the beach or lying in the water along the shore. Many of the plants found here, in all likelihood, have been carried out from the harbor by the receding tide; others have almost certainly been washed in from the coral reefs lying offshore, since several species found elsewhere only on the beach were dredged from these coral reefs; while a few species, represented only by specimens from Bogue Beach, may have come from points farther south, some of these being unknown elsewhere north of Florida or the West Indies, and possibly being brought here by the Gulf Stream from that region or from some of the intermediate submerged coral reefs.[a]

[a] While species found only on the beach can not strictly be included in the flora of Beaufort, they are treated as a part of the algæ of this region. This has seemed proper, since it is very probable that some of these have come from the coral reefs offshore, and it is impossible to distinguish between the species that come from these reefs and those that are brought from other regions. Moreover, in view of the algæ found on these reefs, it is unsafe to assume that any species observed in this region has come from a more distant point. Such species may be found at any time by collectors here or at other places, and it is entirely possible that some of these, even if they do not now occur at Beaufort, may establish themselves here, either in the harbor or on the coral reefs offshore. These species are included in the total number given for the region, but are enumerated in a separate list.



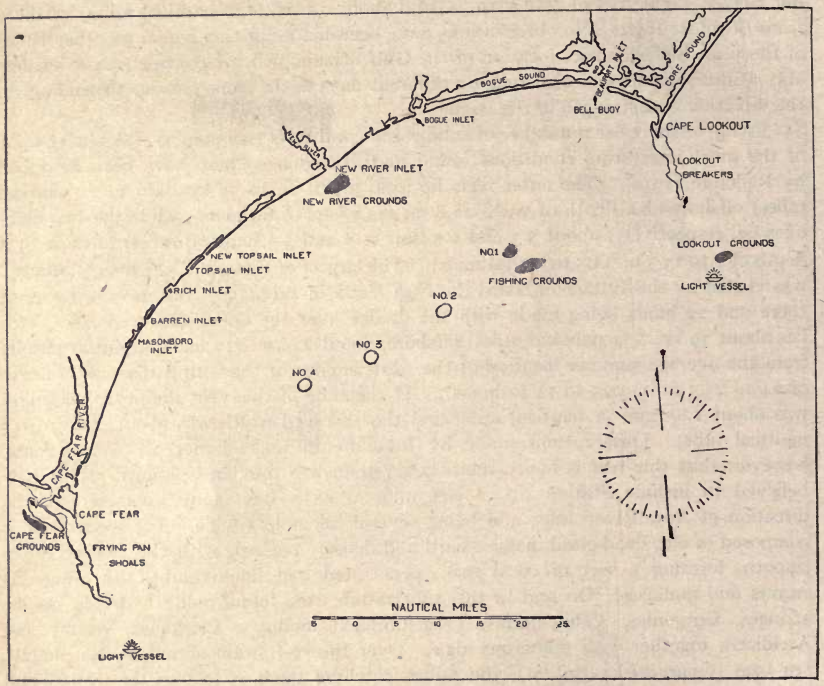
MAP 2.—Beaufort Harbor. Water areas shaded to show nature of bottom.

Hourly observations of the current were made by the U. S. Coast and Geodetic Survey on Cape Lookout Shoals Light Vessel from June 7 to September 1, 1912. These showed that, at this place, the mean current, freed from tidal influence, flowed S. 87° E. with a velocity of 723 m. per hour (0.39 knot) from June 7 to July 5, and N. 85° E. with a velocity of 1.372 km. per hour (0.74 knot) from July 6 to September 1. From this it appears that the Gulf Stream, following the general direction of the coast, has its western edge, on an average, during the summer season, somewhat westward from Cape Lookout Shoals Light Vessel (see map 3), and about 55 km. (30 nautical miles) offshore from Beaufort Inlet. No observations have been made for this region at other times of the year, but the exact location of the Gulf Stream will, of course, vary considerably at different seasons and even on different days of the same season, depending on the direction and strength of the wind.

Lying offshore are a number of submerged coral reefs (see map 3) which offer some of the most interesting conditions found in this region. These have been described by Radcliffe (1914). The outer reefs lie from about 29 to 39 km. (16 to 21 nautical miles) offshore at a depth of 24 to 28.8 m. (13.25 to 16 fathoms), while the two inner ones lie, respectively, about 3.3 and 6.5 km. (1.8 and 3.5 nautical miles) offshore at a depth of 8 to 13.5 m. (4.5 to 7.5 fathoms). The largest of these, the "Fishing Grounds," was visited by the author on board the *Fish Hawk* in May, 1907, two days being spent there and 22 hauls being made with the dredge over the entire observed reef. This lies about 39 km. (21 nautical miles) offshore, about 22 km. (12 nautical miles) inshore from the average summer location of the western edge of the Gulf Stream, at a depth of 24 to 25.5 m. (13.25 to 14 fathoms). At the time of this visit the observed length was about 1.85 km. (1 nautical mile) and the observed width was about 900 m. (0.5 nautical mile). Observations made by Radcliffe in the summer of 1914 indicate, however, that this reef is many times larger than was previously known. It is now believed to include Station No. 1 (see map 3) extending many kilometers in the direction of New River Inlet and being several kilometers wide. The lower part is composed of old, dead coral masses, hard and densely packed, with the surface fairly smooth, forming a sort of coral rock, penetrated and honeycombed by numerous worms and molluscs. On and in this substratum were found many hydroids, corals, sponges, Gorgonias, Echinoderms, Lamellibranch molluscs, Crustacea, worms and Ascidians, together with numerous algæ. Over the reef swam abundant fish, mainly sea bass (*Centropristes striatus*), the sailors catching these as fast as they could pull them in. The bottom around the reef was composed of sand and broken coral, and, except for one large, apparently unattached mass of *Zonaria flava*, all signs of life (including the fish) ceased as soon as its border was passed. Although living coral was abundant on top of the reef, there was no evidence that this is growing toward the surface, the depths recorded on the four visits made by the *Fish Hawk* to this place in 1902, 1907, 1913, and 1914 being almost identical.

Some observations made by Radcliffe on board the *Fish Hawk* in the summers of 1913 and 1914 disclose interesting conditions in the vicinity of this reef. Other reefs seem to be present at various points along the shore, and coral and algæ were found abundantly. Over considerable areas at many points offshore the bottom seemed smooth and hard—apparently consisting of rock as smooth as a floor—and bore scattered specimens of algæ. Offshore from New River Inlet there was found an

abundance of *Dictyopteris polypodioides* growing in scattered patches separated by sand. This growth was observed partially covering the bottom over an area extending at least 22 km. (12 nautical miles) alongshore eastward from the inlet, and from near the shore to at least 13 km. (7 nautical miles) offshore, at a depth of 5.8 to 11.6 m. (3 to 6 fathoms). The actual area occupied by this growth was certainly larger than this, since the inner limit was nearer the shore than the vessel could approach, and the outer limit was in water too deep for observation. Moreover, it was found in abundance



MAP. 3.—Location of known "fishing grounds," mostly submerged coral reefs, offshore from the region of Beaufort, N. C. (From Radcliffe, 1914.) The largest of these, the "Fishing Grounds," is larger than shown here, extending from New River Inlet and probably including Station No. 1. Algæ referred to as coming from coral reef offshore were gathered from this reef.

in July, 1915, offshore from Browns Inlet, about 25 km. (16 miles) northeast of New River Inlet (toward Beaufort), and it may extend westward also from New River Inlet. Its presence here is in striking contrast to the barren bottom observed at other inlets and along most of the shore and raises an interesting question as to the substratum to which it is attached. This must be something other than sand, but its nature was not determined. That rock of some sort is present over considerable portions of the bottom is indicated, however, by the observations of Radcliffe mentioned above and by the further fact that there was evidence of corals and algæ on the bottom in the Gulf Stream about 70 km. (38 nautical miles) offshore at a depth of about 115 m. (60 fathoms).

Similar "fishing grounds" occur off other portions of our coast. To the south of this region there are listed by Goode and associates (1887, pp. 53–55, chart 15) 13 fishing grounds off the coast of South Carolina, 3 off the coast of Georgia, and 1 off the northern coast of Florida. These lie at various distances from the shore at depths of 13.5 to 35.7 m. (7 to 18 fathoms) and have sizes varying from a reef about 800 m. (0.5 mile) square to a circular one having a diameter of 11 to 16 km. (7 to 10 miles). The bottoms are variously described as consisting of rock, limerock, coral rock, coral, shells, or sand, and all are said to bear gorgonian corals and sponges. Under these conditions we can be sure that algæ also occur there.

To the north of Beaufort, rocks are said to occur off the coast of Virginia, and fishing grounds with rocky or sandy bottoms are listed by Goode and associates (1887, pp. 46–51, charts 12–13) off the coasts of Delaware, New Jersey, and the south shore of Long Island, connecting with those off the coast of New England.

These conditions—the existence of a fairly continuous line of submerged rocky reefs extending from subtropical to cold northern waters, the subtropical nature of the flora found on the reefs offshore from Beaufort, the apparent existence of algæ and corals on the bottom in the Gulf Stream, together with the northern course of this stream—seem to furnish excellent means for subtropical species of plants and animals to travel up our coast. Such species can live offshore in water warmed by the Gulf Stream, and, if the local conditions permit, may establish themselves temporarily or permanently on the mainland. These facts probably explain the occurrence of several of the species found in Beaufort Harbor and probably account for all the species found on the beach.

It would be interesting to discover how far north of Beaufort subtropical species may occur. A thorough survey of these reefs, including their geology, oceanographical conditions, flora and fauna, would undoubtedly yield facts of great interest and importance.

GENERAL ACCOUNT OF THE ALGÆ.

The intermediate location of this region gives a flora of considerable interest, containing both northern and southern elements, with southern species predominating. Considering the flora as a whole, of the 142 recognizable species and varieties recorded, 133 have been obtained in proper condition and amount for determination. Of this number, 62 (46.6 per cent) are found in New England, and 91 (68.4 per cent) are known to occur in the Florida-West Indies region. In the different divisions the relative numbers are as follows:

Division.	Species and varieties of algæ identified in Beaufort region.					
	Total.		Recorded for—			
			New England.		Florida-West Indies.	
	Number.	*Per cent.*[a]	*Number.*	*Per cent.*[b]	*Number.*	*Per cent.*[b]
Myxophyceæ	10	7.5	7	70.0	8	80.0
Chlorophyceæ	25	18.8	12	48.0	21	84.0
Phæophyceæ	27	20.3	12	44.4	13	48.1
Rhodophyceæ	71	53.4	31	43.7	49	69.0

[a] Per cent of total number identified in Beaufort region.
[b] Per cent of total number in the division identified in Beaufort region.

Of the 84 genera found in the Beaufort region, 24 genera and 46 species reach here their northern known limit on our coast (Tables 5, 7), while 4 genera and 9 species reach their southern known limit in this region (Tables 6, 7). Furthermore, 20 species not previously recorded for North America have been found, 11 of these being new. Of the 133 identified species and varieties, 78 (58.6 per cent) are recorded for Europe, and 41 (30.8 per cent) for the Pacific coast of North America.

The 46 species reaching their northern limit here (Table 5) have been found as follows:

Growing in Beaufort Harbor	16
Growing only on coral reef	16
Found only on Bogue Beach	11
Known only from other localities	3

The 9 species reaching their southern limit here (Table 6) have been found as follows:

Growing in Beaufort Harbor	7
Growing only on coral reef	1
Known only from other localities	1

The 20 species which are new to North America (Table 7) have been found as follows:

Growing in Beaufort Harbor	6
Growing only on coral reefs	12
Found only on Bogue Beach	1
Known only from other localities	1

The most striking characteristic of the flora is the preponderance of red and the paucity of blue-green algæ. The large number of red algæ indicates the southern relationship of the flora; but here also is found a large northern element, as was shown above. The small number of blue-green algæ is not easily explained. At other places the number is probably greater than is indicated here; indeed, the author saw large masses of undetermined Myxophyceæ covering the rocks of a jetty near Georgetown, S. C. At Ocracoke, N. C., also there were observed masses of blue-green algæ densely covering the ocean beach just beyond the high-tide line for many square meters and covering the wharf piles between tide lines. The number of species found in these places was not large, but other species may have been present. At Beaufort, N. C., however, although one species (*Lyngbya confervoides*) is very abundant, covering walls and jetties for considerable areas between tide lines, repeated careful searches have failed to discover any other species in abundance and have yielded a total of only five species growing in the harbor.

The relative richness, in other respects, of the Beaufort flora as compared with the flora of other localities is shown by the fact that of the 142 species and varieties recorded for the region 132 were found at this place. While a part of this numerical preponderance is undoubtedly due to the fact that Beaufort has been studied more thoroughly than other localities, a large part is due to an actually greater richness of the flora of this region. At no other locality has the author found anything to approach the number of individuals or of species that may be observed at Beaufort on a single collecting trip at any time during the summer.

The 124 identified species and varieties recorded for Beaufort have been found as follows:

	Number.	Per cent.
Growing in the harbor (Table 1)	77	62.1
Growing only on the coral reefs (Table 2)	29	23.4
Occurring only on Bogue Beach (Table 3)	18	14.5

As with other plants, two factors determine the algal flora of any region. First, the conditions prevailing at any place naturally exclude all species which are not able to grow under those conditions; second, of the species which are able to grow in any locality, only a part find access to the region and arrive there under conditions favorable for obtaining lodgment. We may be certain that there are hundreds of other species that could grow at Beaufort if they should be carried there. Since, with marine algæ, artificial means of transport are usually excluded, the flora which we find in any locality favorable for the growth of algæ is determined to a considerable extent by the direction of the currents bringing fruiting plants, fragments, or spores of algæ from other regions. Occasionally, however, an alga may be introduced into a region by artificial means. On one occasion there was found in Beaufort Harbor a fragment of *Halimeda* sp. This seemed a very interesting discovery until it was noticed that there was in the harbor at that time a boat from the West Indies bearing tropical shells and other marine objects for sale. To this boat we may confidently ascribe the presence of the Halimeda. Although this species of alga did not establish itself at Beaufort, its presence there showed the possibility of the distribution of algæ by artificial means of transport.

There is evidence that at least one species has established itself at Beaufort during the progress of these studies. *Rosenvingea orientalis*, known elsewhere in North America only from Guadaloupe and from Wrightsville Beach, N. C., was first found on Bogue Beach in September, 1905, and was not observed in the harbor during that year. The following summer, however, this species was found growing between Fort Macon jetties and on the sea buoy, and in the summer of 1907 it was found on Shackleford jetty as well as on Fort Macon jetties. The records indicate similar facts for a few other species, but are not sufficiently complete to warrant conclusions about them. Miss Dunn (1917) has presented convincing evidence showing that one species of algæ, *Dumontia filiformis*, appeared on the coast of Maine and established itself there between the years 1909 and 1913. This species seems now to have spread in considerable abundance along a large part of the New England coast.

Several species have been found growing in Beaufort Harbor on only one occasion. Such species, while obtaining a foothold, seemed unable to maintain themselves, perhaps because of changing conditions. These may be expected to reappear at any time and may establish themselves. Other species have been found only occasionally, being represented by scattered individuals. Such species seem to be living near the limit of their endurance and may appear and disappear as conditions become more or less favorable. Still other species, not yet observed here, may be expected to appear whenever chance currents bring them to this region under conditions favorable for their obtaining a foothold.

FLORA OF BEAUFORT HARBOR.

Considering, first, the 77 species and varieties found in Beaufort Harbor, the number of these in the different divisions is:

	Number.	Per cent.
Myxophyceæ	5	6.5
Chlorophyceæ	17	22.1
Phæophyceæ	15	19.5
Rhodophyceæ	40	51.9

These are distributed throughout the year as follows:

	Number.	Per cent.
Summer flora only	40	51.9
Spring flora only	22	28.6
Spring and summer floras	4	5.2
Perennial	11	14.3

The strictly summer flora is distinctly southern in its character, but even this has a decided northern element. Of the 40 species and varieties included here, 30 (75 per cent) occur in the Florida-West Indies region, while 17 (42.5 per cent) are found in New England. Of these 17 forms recorded for New England, however, all except four are of general distribution, occurring in the Florida-West Indies region also. The distribution of this summer flora in the different divisions is as follows:

	Number.	Per cent.
Myxophyceæ	4	10.0
Chlorophyceæ	7	17.5
Phæophyceæ	7	17.5
Rhodophyceæ	22	55.0

The strictly spring flora, on the contrary, is distinctly northern, of the 22 species and varieties recorded, 20 (90.9 per cent) being found in New England and only eight (36.4 per cent) being known from the Florida-West Indies region. Its northern character is further shown by the fact that red algæ do not predominate here, the number in the different divisions being:

	Number.	Per cent.
Myxophyceæ	0	0.0
Chlorophyceæ	8	36.4
Phæophyceæ	6	27.2
Rhodophyceæ	8	36.4

The four species common to the spring and summer flora are red algæ. All of these are found in the Florida-West Indies region, while three occur in New England also.

Of the 11 perennial species, all are found in New England while nine occur in the Florida-West Indies region also. The numbers in the different divisions are:

	Number.	Per cent.
Myxophyceæ	1	9.10
Chlorophyceæ	2	18.18
Phæophyceæ	2	18.18
Rhodophyceæ	6	54.54

It is probable that further search would increase the number of species in this list.

FLORA OF CORAL REEFS.

The flora of the coral reefs is predominantly southern, of the 47 identified species and varieties found there (Table 2), 32 (68.1 per cent) being recorded for the Florida-West Indies region and 14 (29.8 per cent) being known from New England.

Comparing the three collections made on the principal reef, we find the species occurring as follows:

Date collected.	Species of algæ identified for coral reefs.				
	Total.	Recorded for—			
		New England.		Florida-West Indies.	
	Number.	*Number.*	*Per cent.*	*Number.*	*Per cent.*
May, 1907	21	9	42.8	18	85.7
August, 1914	25	6	24.0	15	60.0
July–August, 1915	22	10	45.4	20	90.9

This southern relationship is more striking when it is remembered that the visit to the reef in May was made at a time when Beaufort Harbor bore the spring flora, having 90.5 per cent of the species common to New England and only 33.3 per cent of the species common to the Florida-West Indies region. At this time several northern species which occur in this locality only in the spring were found on the reef. The small proportion of the species collected in August, 1914, which are common to other regions is due to the fact that four of these are new, while six are new to North America. If these species are excluded, the figures are New England 40 per cent, Florida-West Indies 100 per cent. Similarly, if two species new to North America collected in July and August, 1915, are excluded, the figures for this period are New England 50 per cent, Florida-West Indies 100 per cent. It could not be illustrated more forcibly that this flora is southern in its nature and that the species which are common to New England are those which are generally distributed and occur along the entire coast.

On all trips there were obtained from this reef species which were not found growing elsewhere in this region. In May, 1907, ten such species were observed, eight being distinctly southern, one being distinctly northern, and one being generally distributed. In August, 1914, there were observed, besides the ten species that are new or new to North America, eight species not found elsewhere in this region, seven being distinctly southern and one being generally distributed. In July and August, 1915, there were collected, besides the two species that are new to North America, nine species not found elsewhere in this region, seven being distinctly southern and two being generally distributed. It is thus seen that the flora that in this region is confined to the reefs is overwhelmingly southern in its relationship. Only four identified species were found in all three collections from the reef, while 14 were obtained in two collections, and 29 were found only once. This is probably an indication not so much of a seasonal distribution as of the abundance of the species occurring there and our ignorance of them. It is highly desirable that a thorough study of these reefs be made.

The southern character of the species occurring on this reef is further shown by the predominance of red algæ. The total numbers found in the different divisions are:

	Number.	Per cent.
Myxophyceæ	2	3.8
Chlorophyceæ	4	7.5
Phæophyceæ	11	20.8
Rhodophyceæ	36	67.9

FLORA OF BOGUE BEACH.

The flora which, in this locality, is found only on Bogue Beach (Table 3) is as pronouncedly southern as is that of the coral reef. Of the 18 identified species and varieties composing this list, 16 (88.8 per cent) are known from the Florida-West Indies region, while only four (22.2 per cent) are recorded for New England. This relationship is again shown by the predominance of red algæ. The total numbers found in the different divisions are:

	Number.	Per cent.
Myxophyceæ	1	4.6
Chlorophyceæ	3	13.6
Phæophyceæ	7	31.8
Rhodophyceæ	11	50.0

These facts support the suggestion previously made that most of these specimens have been washed in from the coral reefs offshore or from the reefs lying to the south of this locality, while some may have been brought by the Gulf Stream from the Florida-West Indies region.

CONDITIONS AT BEAUFORT, N. C.

HARBOR.

The principal factors affecting the growth and distribution of algæ are temperature, light, composition of the water, turbidity, movement of the water (including tidal range), and the nature of the habitat.

TEMPERATURE.

The temperature of the surface water at the laboratory wharf (on Pivers Island) has been taken at 5 p. m. almost daily during three periods, totaling almost four years. A full statement of these figures is given in Table 9. A summary of the records, stated in degrees centigrade, is as follows:

	Maximum.	Minimum.	Average.	Change of average since previous month.		Maximum.	Minimum.	Average.	Change of average since previous month.
	°C.	°C.	°C.	°C.		°C.	°C.	°C.	°C.
January	15.5	5.0	9.8	−1.3	July	31.0	25.0	27.9	+2.7
February	16.7	3.0	9.6	− .2	August	30.0	23.0	27.5	− .4
March	19.5	3.0	12.5	+2.9	September	28.9	17.8	24.8	−2.7
April	23.0	12.0	17.5	+5.0	October	25.0	14.0	19.2	−5.6
May	26.7	18.0	22.4	+4.9	November	20.0	7.8	13.9	−5.3
June	30.0	17.0	25.2	+2.8	December	17.0	6.0	11.1	−2.8

It will be seen that the extreme range of temperature recorded is 28°, from 3 to 31°. The lowest temperature and the lowest average occur in February, while the highest temperature and the highest average occur in July. In the fourth column there is given the change of the average since the previous month. It will be observed that the greatest increase of the average occurs from March to April (5°), while that from April to May is only 0.1° less (4.9°). The greatest decrease of the average occurs from September to October (5.6°), while that from October to November is nearly as great (5.3°). During the other eight months the average change is relatively small.

It is interesting to compare with these figures the surface temperatures (expressed in degrees centigrade) recorded for Woods Hole, Mass., by Sumner, Osburn, Cole, and Davis (1913) and those given for Naples by Berthold (1882), since the former locality has a temperate algal flora, while the latter locality has a subtropical one.

	Woods Hole, Mass.			Naples, Italy.		Woods Hole, Mass.			Naples, Italy.
	Maximum.	Minimum.	Average.			Maximum.	Minimum.	Average.	
	°C.	°C.	°C.	°C.		°C.	°C.	°C.	°C.
January	4.16	−1.95	0.18		August	23.6	17.22	20.97	25–27
February	2.78	−1.95	− .56	8–10	September	21.67	17.22	19.55	18–22
March	6.67	−1.38	2.04		October	18.33	10.83	15.26	
April	11.11	2.5	6.61		November	12.78	3.6	9.03	.....
May	16.39	8.05	12.75	15–19	December	8.6	− .28	3.01	.....
June	20.56	14.16	16.94						
July	23.33	17.22	20.43	20–25					

At both of these places the highest temperature occurs in August and the lowest temperature in February. Woods Hole has a range of 25.55°, from −1.95 to 23.6°, while Naples has a range of 19°, from 8 to 27°. These figures indicate that Beaufort has a higher maximum and a lower minimum than Naples; but the record of Naples is less complete than that of Beaufort.

LIGHT.

While we have as yet no satisfactory measure of light, we can measure, in an approximate way, the relative effect under different conditions of the rays of light which affect photographic paper. This has been done in the present instance by means of the Clements photometer. This instrument uses a strip of solio paper, successive portions of which are exposed at will through a small slot, the slot being opened or closed as desired by means of a sliding cover. Standards for comparison are obtained by exposing portions of the paper to direct sunlight for different measured intervals of time. Another portion of the paper is exposed for a definite time in the situation whose light is to be tested. By comparison it is then determined which of the standards is darkened to the same extent as the paper exposed in the test situation. From the relative time of exposure of the test paper and this standard it is thus possible to estimate the relative amount of light in the test situation compared with full sunlight. For example, if paper exposed in a certain situation for 10 seconds is darkened to the same extent as a standard exposed to full sunlight for 5 seconds, we estimate that the light in this situation is 50 per cent as strong as full sunlight. It is, of course, necessary to make new standards for every series of tests, since the intensity of full sunlight will itself vary at different times and on different days.

Since the only photometer available to the author at that time was one intended for use in the air, this form was employed, being adapted as follows: All exposures were made with the photometer placed in a glass preserve jar of sufficient diameter to permit the photometer to lie flat on the bottom. The photometer was held in place by paper packed into the jar, care being taken that the slot for exposing the solio paper was not shaded by the packing. In a dim room the slot was opened, the photometer was placed in the jar and securely packed, and the jar was tightly wrapped in black cloth. This was then taken to the desired situation, the jar being held horizontally with the slot directly on top, the cloth was quickly removed for the desired number of seconds and then quickly replaced, and the jar was then brought back into the laboratory. All changes in the apparatus were made in a dim room at a considerable distance from any window. The standards were obtained in this way by exposing the photometer within the glass jar to direct sunlight on an upper, unshaded, southern porch.

For exposing the photometer below the surface of the water a shallow box, open at the top and of the proper size to hold the jar horizontally, was built, the sides of the box being just high enough to hold the jar in place and not shading the upper part of it. This box was then fastened to a handle marked with the desired distances. In a dim room the jar containing the opened photometer was placed horizontally in this box with the slot directly on top, and the box was tightly wrapped with black cloth. This was carried in a boat to the desired locality and held at arm's length below the water, the black cloth was then removed, and the jar immediately sunk to the desired depth and held at that level for a definite time. The jar was then quickly brought within reach and immediately covered with the black cloth, not more than a second being required for this manipulation. The apparatus was then carried to the laboratory, where all changes of the photometer were made in a dim room.

While the jar undoubtedly diminished the light reaching the photometer, this decrease would be the same in the standards and the tests. The effects of the light in these two cases may, therefore, be directly compared.

Two records, one at high and one at low tide, were obtained in this way in the channel in front of the laboratory wharf in July, 1907. In the first of these the standards were made from 1 : 15 p. m. to 2 p. m., July 17, and the measurements below the water were made from 1 : 15 p. m. to 4 p. m., July 18, high tide on this day occurring at 2 p. m. In some cases, where the color of the test did not exactly match that of any standard, the time of the standard having an effect equivalent to that of the test was obtained by interpolating between the two standards showing the colors nearest to that of the test. Standards were made by exposing to direct sunlight as described above for 60, 30, 25, 22, 20, 15, 10, 5, 3, 2, and 1 second. The results were as follows, the first column giving the depth below the surface at which the test was exposed, the second column giving the time of the exposure of the test, the third column giving the time of exposure of the standard having a color equivalent to that

of the test, and the fourth column giving the calculated percentage intensity of the light at the respective depths compared with full sunlight:

Depth.	Length of exposure.	Equivalent standard.	Relative intensity.
	Seconds.	*Seconds.*	*Per cent.*
1 cm.	60	28.0	46.6
30 cm.	60	23.0	38.3
60 cm.	60	22.0	36.6
90 cm.	60	9.0	15.0
1.2 m.	60	5.0	8.3
1.5 m.	120	7.0	5.8
1.8 m.	180	4.5	2.5
2.1 m.	240	2.8	1.2
2.4 m.	300	3.0	1.0

The second record was made from 1 : 15 p. m. to 2 : 30 p. m., July 24, low tide on this day occurring at 2 : 15 p. m. The standards were made at 2 : 30 p. m. of the same day and were exposed for 60, 45, 30, 25, 20, 15, 10, 5, and 3 seconds. The results were as follows:

Depth.	Length of exposure.	Equivalent standard.	Relative intensity.
	Seconds.	*Seconds.*	*Per cent.*
1 cm.	60	40.0	66.6
30 cm.	60	17.5	29.1
60 cm.	60	2.8	4.6
90 cm.	120	3.0	2.5
1.2 m.	120	3.0	2.5
1.5 m.	120	3.0	2.5

While these two records differ considerably, they agree in their main points and indicate several interesting conclusions: (1) A considerable portion of the light (nearly one-half) did not penetrate below the surface, probably because of the reflection from the water and the suspended matter; (2) of the light which entered the water nearly one-half did not penetrate to a depth of 30 cm.; (3) at a slightly greater depth (1.2 m. at high tide, 60 cm. at low tide) the light was so reduced as to be almost lacking. These results are of great interest when considered in connection with the vertical distribution of the algæ. While some of the difference in the records may be due to errors in the determinations, a considerable part is probably due to the fact that one was taken at high and the other at low tide. The water at high tide is notably clearer than that at low tide, and the record taken at high tide shows a correspondingly greater light intensity.

These records, of course, show the effect of only the rays affecting solio paper, but it is these rays (toward the violet end of the spectrum) that are least absorbed by water. It is not known what proportion of the different rays penetrate water as turbid as that occurring here, or what is the intensity of the rays at the red end of the spectrum that reach the slight depths at which these measurements were made. There are evident errors in the methods used, but since the figures obtained could be, at best, only approximations, it did not seem worth while to give the time necessary to improving the records. The figures given refer only to the water in the channel in front of the laboratory wharf. Efforts to obtain records from other localities far removed

from the laboratory were not successful, since the necessary changes of the photometer could not be made out of doors. These figures probably represent about an average of the conditions occurring through the greater part of the harbor. At certain places, especially near the inlet where the algæ are more abundant, the water is somewhat clearer.

SALT CONTENT OF WATER.

Determinations of the salt content of the water from five places in Beaufort Harbor were made by Wheeler (1910) in the summer of 1909 during the progress of the present study of the algæ. The water was obtained from (A) Beaufort Inlet; (B) the laboratory wharf; (C) Bogue Sound opposite Moorehead City; (D) between the eastern end of Beaufort and Bird Island Shoal; (E) Green Rock in Newport River near the entrance to Core Creek. The results, stated in parts per 1,000 grms. of water, were as follows:

	A.	B.	C.	D.	E.
NaCl	28.043	27.836	27.977	28.006	24.796
KCl	.842	.742	.751	.751	.702
$MgCl_2$	3.379	3.245	3.300	3.335	2.972
$MgSO_4$	2.417	2.328	2.320	2.372	2.062
$CaSO_4$	1.171	1.168	1.202	1.188	1.039
$CaCO_3$	.220	.214	.214	.215	.215
Total	36.072	35.533	35.764	35.867	31.786
Specific gravity at 28.7° C	1.0227	1.0222	1.0226	1.0227	1.0193

As is shown, both the total salt content and the relative amounts of the different salts vary in different places and at different times, the total ranging, in these analyses, from 3.1786 per cent to 3.6072 per cent.

The density, of course, varies at different times, being largely determined by the amount of rain and the state of the tide. At times, after continued hard rains, the water in the harbor has, for days, the color of weak, muddy coffee, due to water coming from the inland juniper swamps. Daily salinometer readings have been made at 5 p. m. at the laboratory wharf (on Pivers Island) since June, 1913. A summary of these is as follows:

	Maximum.	Minimum.	Average.		Maximum.	Minimum.	Average.
1913.				1914.			
June	1.0228	1.0184	1.0209	January	1.0248	1.0186	1.0212
July	1.0238	1.0216	1.0228	February	1.022	1.010	1.0179
August	1.0226	1.020	1.021	March	1.0204	1.0112	1.0173
September	1.0204	1.0132	1.0168	April	1.0218	1.015	1.0183
October	1.0236	1.017	1.0199	May	1.0234	1.019	1.0212
November	1.024	1.0102	1.0209	June	1.0258	1.021	1.0234
December	1.0256	1.0192	1.0226	July	1.0246	1.022	1.023

It will be observed that the recorded density ranged from 1.010 to 1.0258. The general average, obtained by averaging the monthly averages, is 1.0205. In these figures no account is taken of the temperature, since in such salinometer records the errors of reading are almost certainly greater than the temperature corrections. For the same reason the maxima and minima are not accurate, but probably cover the

range of variation. The averages, however, are probably fairly accurate, since they are obtained from a large number of readings where the errors probably balance each other. The general average, 1.0205, may, therefore, be taken as closely approximating the mean density of the water at the laboratory wharf. At other places in the harbor the density will, of course, be different from this. Since algæ grow throughout the harbor, some of them will be exposed to greater densities and some to lesser densities than those recorded here.

Several salinometer readings have been made by the author at other places in this region. While these have not the value of the daily records made at the laboratory wharf, they indicate the comparative density at other places. They are as follows:

Newport River near "Green Rock," low tide	1.016
North River near Lenoxville, low tide	1.0188
Pamlico Sound, Ocracoke, low tide	1.011
Coral reef off Beaufort	1.0242

TURBIDITY.

The water from the open ocean outside of the inlet contains a considerable amount of suspended matter, as is evident when this water is filtered, while the water within the harbor has still more fine, suspended matter and is, at times, very turbid. All rocks, shells, and posts under water are soon covered with a thick deposit, and at many places in the harbor the bottom is covered with mud up to a meter or more in depth. In the harbor and in Bogue Sound the amount of suspended matter seems to increase as we go farther from the inlet, while in the sound back of Shackleford Banks the water is decidedly clearer, owing to the strong current running in from the ocean at this place. Farther back in this sound the water is as turbid as in the harbor.

This turbidity not only reduces the light penetrating the water but itself affects the vertical distribution of algæ, since much of the suspended matter is deposited on all objects in the water. The older portions of the broader algæ (as Dictyota, Padina, the leaves of Sargassum) are more or less thickly covered by this mud settling from the water.

MOVEMENTS OF WATER.

The usual maximum range of tide (at the spring tides) is 0.97 m. (3.2 feet), the usual minimum range (at the neap tides) is 0.7 m. (2.3 feet), and the usual mean range is 0.82 m. (2.7 feet). The tides may, however, vary considerably from these figures, the actual height and range attained depending in part on the direction and strength of the wind. The greatest range observed by the author at the laboratory wharf is 1.31 m. (4.3 feet). The smallest range observed is 0.48 m. (1.6 feet). Under exceptional conditions the low tides are higher than the high tides recorded on other days in the same month, while at other times the tides are unusually low. Although there is not a very great difference in the height of water at high and low tides, there is a great difference in the amount of light reaching the algæ at these times. Except on Shackleford jetties, where the water is clearer, no algæ were found in the harbor below 1.4 m. below low water, and the majority were found within 75 cm. below low water. Most of the algæ have, therefore, about twice as much water over them at high tide as at low tide. Furthermore, during summer and autumn the greater number of algæ grow almost up to the surface of the water at low tide. For these parts of the plants

the difference in the amount of water covering them at high and low tides is much greater than is indicated by the figures given above. For the species growing above low water the difference is, of course, still greater. Since light penetrates to such a slight depth in this water, the difference in the amount of light received by the plants at different stages of the tide must be very great. The difference is, however, partly neutralized for the algæ growing near the inlet and even as far back as the laboratory, since the water of the ocean is clearer than that of the harbor. This ocean water, entering the harbor at flood tide, pushes the more turbid water before it and mixes with it, so that, as was shown above, the water of the harbor is clearer at high than at ow tide.

Since the harbor is a comparatively small body of water and is well sheltered by land, the water is usually smooth throughout the greater part of its area. Near the inlet, however, there is considerable movement, although even here there are usually no waves. Even the slight movement that does occur here, however, probably affects the algæ growing on Fort Macon and Shackleford jetties by washing off the sediment that settles on them.

HABITATS.

The bottom throughout the harbor consists principally of sand, with some areas covered by mud or shells. (See map 2.) The mud and sand furnish no place of attachment for algæ. The shells furnish excellent places for attachment, but do not bear algæ, probably because of the turbidity of the water above them. Algæ are, however, found attached to single shells and other supports below low water along the shore and, sparingly, on the shoals.

The numerous wharf piles occurring here would seem to offer excellent habitats, but during the summer and autumn no algæ were ever found on them, while, on the contrary, during the spring they bore an abundant growth of algæ. The reason for this difference is not apparent.

There remain, as possible algal habitats, the jetties at Fort Macon, at Shackleford and on the laboratory island, and the brick walls occurring along the town shore. These jetties bear the greater number, both of species and of individuals, of the algæ growing in the harbor, while the walls bear a limited number of species. Small species of algæ are found, too, in some abundance on the buoys that mark the channel into the harbor.

CORAL REEF.

The physical conditions existing on the coral reef offshore have already been described. Here it need be said only that the surface temperature at noon on May 15, 1907, was 21.11° C., the temperature at a depth of 25.5 m. was 19.44° C., and the density of the surface water (measured by a salinometer) was 1.0242. At this time the temperature of the surface water in the harbor varied, in different places and on different days, from 20.5° C. to 23° C., and the density varied from 1.0165 to 1.0212.

DISTRIBUTION OF ALGÆ AT BEAUFORT.

REGIONAL.

The regional distribution of algæ, their occurrence throughout the world, is, like that of other plants, determined largely by temperature. Whether a given algal species is able to exist in a given locality will depend absolutely on its ability to endure the maximum and minimum water temperatures occurring in that locality. It need not, however, be obliged to endure these extreme temperatures in its vegetative condition, but may exist for long periods by means of spores or fragments, resuming its vegetative state with the return of more favorable temperatures. Setchell (1915) has shown that the majority of the species of algæ occur in regions having a range of not more than 10° C., and that those occurring in regions having a greater range than this accommodate themselves to the general law by their seasonal distribution, etc.

Of the species which are able to exist in any given locality, some will thrive and will predominate, others will barely maintain a foothold, while others will appear and disappear at different times. The relative abundance of the different species occurring in any locality will be determined by the ability of these species to thrive under the conditions found there and to compete under these conditions with the other species growing in the region. To become abundant, a species must be able not only to endure the extreme conditions, but also to grow luxuriantly under the usual conditions. The factors most affecting the relative abundance of the species of marine algæ seem to be the temperature, density, and turbidity of the water, and the intensity of the light occurring, not on single days, but throughout the growing season.

As has been mentioned, the intermediate position of Beaufort makes its flora particularly interesting. Here *Codium tomentosum*, *Dictyota dichotoma*, *Padina vickersiæ*, and other strictly southern forms grow along with the more northern *Fucus vesiculosus* and *Polysiphonia harveyi*. As a rule, however, the northern and southern species do not grow together, the former occurring in the spring and the latter in summer.

Setchell (1915), in considering the effect of temperature on the distribution of algæ, distinguishes the following regions, based on the average temperature of the water during the summer expressed in degrees centigrade:

	°C.		°C.
Upper boreal	0 to 10	South subtropical	20 to 25
Lower boreal	10 to 15	South temperate	15 to 20
North temperate	15 to 20	Lower austral	10 to 15
North subtropical	20 to 25	Upper austral	0 to 10
Tropical	25 N. to 25 S.		

Since the average water temperature at Beaufort during the months from June to September is 26.35 °C., this classification would place the Beaufort area at the northern limit of the tropical region. It would seem, however, that the Beaufort flora should more properly be included in the subtropical region, and the limits given by Setchell should be modified.

SEASONAL.

As is shown in Table 1, the flora of spring and summer are very different. Of the 77 species and varieties growing in the harbor, only 15 (19.5 per cent) are found at both seasons, 11 of these being perennial and 4 having been found from April to October.

During the winter of 1908–9 monthly collections of all species observed were made for the author from the time of his departure from the laboratory, October 20, 1908, until his return, June 30, 1909. While more careful studies would probably alter the present data in some details, these collections and those made by the author in May, 1907, and April, 1908, give a fair picture of the seasonal distribution of the algæ in the harbor.

The species occurring there in the summer may be grouped as follows:

DOMINANT SPECIES.

Lyngbya confervoides.
Codium decorticatum.
Codium tomentosum.
Sargassum filipendula.
Dictyota dichotoma.
Padina vickersiæ.
Gracilaria confervoides.
Gracilaria multipartita.
Hypnea musciformis.
Chondria dasyphylla.
Dermatolithon pustulatum.

OCCURRENCE MORE LIMITED.

Ulva lactuca.
Ulva fasciata.
Ectocarpus mitchellæ.
Rosenvingea orientalis.
Fucus vesiculosus.
Erythrocladia recondita.
Erythrotrichia carnea.
Goniotrichum alsidii.
Acrochætium dufourii.
Acrochætium hoytii.
Acrochætium virgatulum.
Gelidium coerulescens.
Gelidium crinale.
Gymnogongrus griffithsiæ.
Actinococcus aggregatus.
Agardhiella tenera.
Eucheuma gelidium.
Champia parvula.
Lomentaria uncinata.
Chondria sedifolia.
Herposiphonia tenella.
Polysiphonia harveyi.
Polysiphonia denudata.
Ceramium tenuissimum.

The other species of the summer flora mentioned in Table 1 have been found only occasionally.

By the middle of October changes in the flora have become evident. Dictyota has become relatively scarce, and Padina is less abundant than formerly, the plants of both species being small and showing signs of degeneration; *Chondria dasyphylla* has almost disappeared; Hypnea is still abundant and shows little change except that there seems to be a greater preponderance of tetrasporic plants than formerly; Codium and *Gracilaria confervoides* are still present; Ectocarpus is abundant and conspicuous; large plants of Fucus are abundant and the fruits are well developed.

During November this change continues. Dictyota becomes still scarcer and finally disappears; Hypnea is reduced to small sterile plants, the condition in which it passes the winter (Pl. CI, fig. 2); and the first of the spring flora, *Petalonia fascia*, makes its appearance.

In December we find the last plants of Padina and the species growing on this, Erythrotrichia and Goniotrichum; *Gracilaria confervoides* has disappeared; *Codium tomentosum*, Champia, and *Chondria sedifolia* are still present; *Enteromorpha prolifera*, Agardhiella, and *Gracilaria multipartita* are more conspicuous; Petalonia grows to a large size; while occasional plants of Grinnellia and Dasya are found.

By January Champia and *Chondria sedifolia* have disappeared; *Ectocarpus confervoides* has replaced the summer species, *E. mitchellæ;* Grinnellia has become conspicuous, and small plants of Porphyra have appeared.

In February we find the last reduced plants of *Codium tomentosum* (*C. decorticatum* having disappeared earlier) and of *Chondria dasyphylla*. From this time the flora consists entirely of perennial and spring species. Porphyra has attained a large size; *Enteromorpha linza* has appeared; and *Enteromorpha prolifera*, *Ectocarpus confervoides*, Petalonia, Porphyra, Agardhiella, *Gracilaria multipartita*, and Grinnellia are the principal species composing the flora.

In March, the algæ are scarcer than at any other time during the year, but the perennial and spring species already mentioned are present without change, except that small plants of Leathesia have made their appearance.

During April the spring flora attains its greatest development. The dominant form throughout the harbor and along all the shores is *Ulva lactuca*, which occurs on all rocks and forms large masses lying free on the bottom. Closely rivalling this are *Enteromorpha prolifera* and Porphyra growing on all rocks and posts throughout the harbor. These three species are extremely abundant everywhere, but in limited areas they are surpassed by *Polysiphonia nigrescens* and *Ceramium strictum*. The species occurring here at this time may be grouped as follows:

ABUNDANT.

Lyngbya confervoides.
Enteromorpha linza.
Enteromorpha prolifera.
Ulva lactuca.
Ectocarpus confervoides.
Petalonia fascia.
Myrionema strangulans.
Leathesia difformis.
Fucus vesiculosus.
Porphyra leucosticta.
Acrochætium virgatulum.
Gelidium cœrulescens.
Agardhiella tenera.
Gracilaria multipartita.
Champia parvula.
Lomentaria uncinata.
Grinnellia americana.
Chondria tenuissima var. baileyana.
Polysiphonia nigrescens.
Dasya pedicellata.
Ceramium strictum.

OCCURRENCE LIMITED.

Enteromorpha flexuosa.
Enteromorpha intestinalis.
Chætomorpha melagonium f. rupincola.
Rhizoclonium riparium.
Cladophora flexuosa.
Bryopsis plumosa.
Ectocarpus siliculosus.
Stilophora rhizodes.
Sargassum filipendula.
Bangia fusco-purpurea.
Acrochætium corymbiferum.
Gelidium crinale.
Gymnogongrus griffithsiæ.
Hypnea musciformis.

Young plants of several species were observed at this time. Several specimens of Codium 3 to 12 mm. tall were found on shells in the clearer, deeper water north of the laboratory. Fucus showed, in addition to the large plants, many germlings 2 to 3 mm. tall. Small plants of *Chondria dasyphylla* also were observed.

Besides the germlings of Fucus, many large plants up to 14 cm. tall were present. These were entirely without fruit. Ulva, *Enteromorpha prolifera*, Lomentaria, and Champia grew more abundantly and to a larger size than in summer. Fruiting plants of Hypnea 1 to 6 cm. tall were observed, all of these being tetrasporic.

During May the spring species begin to disappear, some of the plants showing signs of disintegration. *Enteromorpha linza*, *E. prolifera*, *Chætomorpha melagonium f. rupincola*, Stilophora, Bangia, Porphyra, Dasya, *Polysiphonia nigrescens*, Grinnellia, and Ceramium are, however, still present. Hypnea has now attained its summer condition,

the plants reaching a size of 22 cm.; *Chondria sedifolia* has appeared, and one small mass of *Rhodymenia palmetta* was found on Fort Macon jetty.

By June the spring flora has disappeared and the summer flora is established. The growth of the summer species at this time is very rapid. On May 14, 1909, the jetties at Fort Macon were carefully searched for Dictyota without revealing a trace of this species. On June 9, when the next collection was made, there were found numerous plants 20 to 29 cm. tall which had matured and liberated their sexual cells. The species present now include well-developed fruiting plants of Codium, Dictyota, Padina, Hypnea, *Chondria dasyphylla*, *C. sedifolia*, and Herposiphonia, and plants of Rhodymenia 6 cm. tall. None of the spring species was collected at this time.

All of the summer species are present before the first of July and maintain themselves until the following October or November.

From these facts we can picture the seasonal succession as follows: With the advent of colder temperature, the summer flora begins to disappear by the middle of October, the larger number of the species disappearing by November or December, others dropping out with each successive month, but some remaining until February. The first of the spring flora makes its appearance in November, other species appearing with each successive month, the flora, however, remaining relatively sparse during the winter, the smallest number of species being found in March. With the coming of warmer temperature, this flora becomes more abundant and reaches its greatest profusion in April, after which time it begins to dwindle and disappears by June. The first of the summer flora appears in April, others appear in May, and all are present before the last of June.

If the seasonal behavior of the algæ is compared with the recorded water temperature, it is observed that the disappearance of the summer flora in October and November is coincident with the greatest decrease in temperature; the appearance of the spring flora in November and the succeeding months follows this diminution; the time of greatest scarcity of algæ, in March, follows the lowest minimum temperature reached; the rapid increase of the spring flora to its maximum in April is coincident with the greatest increase in temperature, while its disappearance during May is coincident with the continued increase; and the appearance of the summer flora in April is coincident with this greatest increase and its profusion in June follows this great increase of temperature. It would scarcely be possible to find a more direct relation between temperature and the seasonal distribution of plants than is shown here. From this it seems evident that, while light probably has its effect, the seasonal distribution of algæ is determined to a very great extent by the temperature. More exact studies would probably show interesting relations between the temperature and the individual species occurring here.

The manner in which the summer species exist during the winter and the spring species exist during the summer at this place has not been determined. During the seven summers spent at the Beaufort laboratory, two small plants of Grinnellia and a few small plants of Dasya have been observed, but no other of the spring species has been found here after May, and none of the summer species has been found after February. Lewis (1914) has shown that, at Woods Hole, Mass., many of the summer species of red algæ occurring there (Dasya, Polysiphonia, and others) persist during the winter by means of the minute holdfasts of sporelings, the other portions of these sporelings and all of the older plants dying at the approach of cold weather. The plants arising from these holdfasts the following summer were mainly tetrasporic. Probably some such method

carried the species over the unfavorable seasons at Beaufort. The rocks on which Dictyota and Padina grew the preceding summer and on which they occurred abundantly the following summer were carefully searched by the author under favorable conditions in April, 1908, without revealing a trace of these species. It is probable, however, that a microscopic examination would show these and other algæ present on the rocks below low water.

It is interesting to note that, although cystocarpic and tetrasporic plants of Hypnea are present in the summer in about equal numbers, a collection of 55 plants of this species taken at random in October showed 45 tetrasporic plants and 10 sexual ones, and all the fruiting plants observed in April were tetrasporic. Lewis (1914) has shown that the preponderance of tetrasporic plants in the early summer exhibited by the annual red algæ at Woods Hole is due to the fact that the two generations are produced alternately, the last crop of the summer being prevailingly sexual, and the carpospores borne by this crop producing the sporelings whose holdfasts persist through the winter. The perennial algæ at Woods Hole show no such discrepancy in the numbers of sexual and tetrasporic plants. In the present instance it seems that the tetrasporic plants of Hypnea, a perennial species, are themselves more resistant to cold than the sexual plants. Further studies are needed on this subject both here and in other regions.

The seasonal life cycle of Fucus may be summed up here for comparison with other regions. Young plants were observed in April along with large, old, sterile plants. The swollen receptacles become evident about June, but remain small and inconspicuous during July, becoming gradually larger and more conspicuous during August and September, and reaching full size about the latter part of October, the plants showing large, well-developed fruits from November to January or February. After this time all plants observed were sterile.

It is of interest to note that in May, 1907, when Beaufort Harbor bore almost entirely a spring flora, the coral reef offshore bore such strictly southern forms as Udotea, Dictyota, Zonaria, Nitophyllum, Chrysymenia, and others, along with the spring species of Dasya and Grinnellia, although at this time the water at the depth of this reef was at a lower temperature than that in the harbor. The explanation of this can not be given surely without further study, but certain differences between the harbor and the reef are evident. The greater clearness and higher salinity of the water over the reef probably play a part, but the chief factor probably is that the water at the depth of the reef, as may confidently be believed, does not fall to the low temperature found in the harbor in winter. This suggestion is supported by the species found on Bogue Beach during the winter from December, 1908, to March, 1909. Besides the species growing in the harbor, there were found during this time *Zonaria flava*, *Z. variegata*, *Nitophyllum medium*, *Polysiphonia havanensis*, and *Spermothamnion investiens*. The *Zonaria variegata* and *Polysiphonia havanensis* were found only once and may have been brought here by the Gulf Stream, but the other three species were not uncommon and may confidently be believed to have come from the coral reef offshore. *Codium tomentosum* was collected in December and April but not in the intervening months, while Dictyota was not found there until after its occurrence in the harbor in June. Data concerning the conditions and algæ occurring on the reef in winter would be of considerable interest, since it seems very probable that several species persist there throughout the year.

A comparison of the seasonal distribution of the Beaufort species which are found at Woods Hole and at Naples is given below, the numbers referring to the number of species and varieties common to Beaufort found in the other localities at the respective seasons:

Locality.	Beaufort summer flora.			Beaufort spring flora.				Beaufort perennial flora.		
	Winter.	Summer.	Perennial.	Winter.	Spring.	Summer.	Perennial.	Winter.	Summer.	Perennial.
Woods Hole	.....	13	3	1	1	16	4	.....	7	4
Naples	9	3	2	5	1	4	1	1	.....	5

In this case many of the species recorded above for winter at Naples are found there from autumn through spring, and some of the species recorded for summer at Woods Hole are found there in spring and summer. In general, though, it will be seen that the relationships of the Beaufort flora are greater with that occurring at Woods Hole in summer and at Naples in winter.

The relations between the occurrence of any single species and the temperature are, however, frequently different in different localities. This is shown below where there is given the seasonal distribution of five species at Beaufort, Naples, and Woods Hole, with the range of the average temperature, in degrees centigrade, recorded in each locality during the time of occurrence of each species:

	Beaufort.	Naples.	Woods Hole.
Champia parvula	April to December, 17.5 to 27.9 to 11.1°.	Autumn to spring, 25 to 8 to 19°.	July to October, 20.43 to 20.97 to 15.26°.
Chondria dasyphylla	April to February, 17.5 to 27.9 to 9.6°.	Autumn to spring, 25 to 8 to 19°.	
Chondria tenuissima	April to June, 17.5 to 25.2°	Summer to autumn, 20 to 27 to 18°.	
Dasya pedicellata	December to June, 11.1 to 9.6 to 25.2°.	Spring to summer, 8 to 27°	
Polysiphonia denudata	July to October, 27.9 to 19.2°.	Perennial, 8 to 27°	

It will be observed that, while all of these species have the same seasonal distribution at Woods Hole, they occur at different seasons at Beaufort and at Naples, and, what is more important, they appear and disappear at different temperatures in each of the three localities. Further studies are needed to explain these facts.

Howe (1914) lists the following species found at and near Orient, N. Y., as having been gathered in Long Island Sound during the month February 7 to March 7: *Ulva lactuca*, *Chætomorpha linum*, *Sargassum filipendula*, *Agardhiella tenera*, *Champia parvula*, *Polysiphonia nigrescens*, *Ceramium rubrum*, *Dermatolithon pustulatum*. While further search would probably increase the number of perennial species listed for Beaufort, there is no evidence that Champia or Polysiphonia persists there during the winter.

VERTICAL.

The vertical distribution of the algæ at Beaufort is exceedingly limited, the total range of all species growing in the harbor being only about 2.2 m., from the usual high-tide line to about 1.4 m. below the usual lowest low tides. In fact, except at Shackleford jetties and the outermost jetty at Fort Macon, where the water is clearer and the algæ extend deeper, the great majority of algæ occur within a zone of 90 cm., from the level of the usual lowest low tide to 90 cm. below this. A careful search was made on

the inner jetties at Fort Macon by means of oyster tongs and diving, a day being chosen when the water was about 15 cm. below the usual low tides. This showed algæ occurring abundantly to a depth of about 75 cm. below the usual level, then becoming scarcer and ceasing about 1.4 m. below this level, none being found as low as 1.7 m. In October, 1906, one of the jetties at Fort Macon, being undermined by the current, sank to a depth of about 6 m. When the rocks of this jetty were dredged up the following July they were entirely bare of algæ, although in the previous autumn they had borne numerous plants of Fucus, Sargassum, Dictyota, Hypnea, and other species occurring in this locality.

The lower limit of the algæ in this region is undoubtedly determined by the turbidity of the water and the consequent great diminution of the light penetrating to even moderate depths. It has been shown that the light reaching a depth of 90 cm. has an intensity of not more than 15 per cent of that of full sunlight, and that from 60 cm. to 1.2 m. there is a great decrease in the strength of the light. It will be observed that it is just at these depths that the algæ become scarcer and finally cease.

This turbidity, however, besides affecting the amount of light, probably itself plays a part in limiting the depth to which the algæ may grow, since these will receive sediment from all the water above them, and so will receive more deposits the greater the depth of the water covering them.

It is worthy of note that, while the algæ in the harbor grow to a depth of only 1.4 m., those on the coral reef grow to a depth of 25.5 m. This is undoubtedly due to the greater clearness of the water over this reef. All of the plants of Brongniartella, Dasya, Grinnellia, and Nitophyllum gathered from this reef were exceedingly pale in color, being much paler than plants of Dasya and Grinnellia growing in the harbor at the same time or than plants of Brongniartella and Nitophyllum observed in summer. This pale color may have been due to the weak light occurring at that depth or to a combination of this and other factors, but we do not yet know enough about the color of algæ to venture an explanation.

Except in the spring, the upper limit of the great majority of algæ in this region is determined by the height of the usual lowest low tides. *Lyngbya confervoides*, Hydrocoleum, several undeterminable species of Myxophyceæ, mats composed of minute plants of Enteromorpha, Ulva, Chætomorpha, and Cladophora, and plants of Fucus, Gelidium, Gymnogongrus, and Actinococcus occur between tide lines; but, except for these species and occasional plants growing in shaded or otherwise especially favorable locations, all algæ occurring here in summer are strictly limited to the zone below low tide. This is undoubtedly due to the intense insolation and heat to which the exposed plants are subjected, the air temperature sometimes rising to 36° C. At the time of the spring tides, when the range of tide is greatest, low tide occurs here about noon, so that all the algæ above low water are exposed to the sun during the hottest part of the day. Plants of Gracilaria, Hypnea, Chondria, Herposiphonia, and Nitophyllum have frequently been observed with a part or all of their thallus exposed by successive very low tides, and in every case they had been killed to the level of the water. Dictyota, Padina, and Rosenvingea seemed slightly more resistant, since plants that had been similarly exposed appeared uninjured in some cases, but at other times they too were killed to the water level. While a single very low tide, caused by the wind, may kill the exposed parts of the most tender species, it has little effect on the range of the algæ, but the successive

very low tides, occurring at the time of the new and full moons, kill every plant growing above their level, with the exception of the species noted above, and therefore strictly determine the upper limit of all other species in this region.

The limits of the species growing between tide lines should be noted. Enteromorpha, Ulva, Chætomorpha, and Cladophora may be neglected in this connection, since these species occur here as mere fragments a few millimeters tall (in some being scarcely more than resistant holdfasts) and seem to merely endure the exposure between tide lines. Hydrocoleum has been collected only one time, intertwined with Gelidium. *Lyngbya confervoides* forms large mats covering all the walls and many of the jetties throughout the harbor from the usual low tide to the usual high-tide line. Fucus has about the same vertical range. Gelidium occurs in a zone about 60 cm. wide, from about 10 cm. above the usual low tide to about 12 cm. below the usual high-tide line. Gymnogongrus, with its parasitic Actinococcus, occurs from about 10 cm. below to about 30 cm. above the usual low tides. All of these species are enabled, by their structure, to endure prolonged exposure, and all of them except Gymnogongrus seem to require emersion, having their lower limits determined by the height of the usual low tides.

As the great majority of the species occurring here in summer are restricted by the heat to the zone below low tides, so those growing here in winter have their upper limit determined by the low-tide line on account of the cold, the air temperature sometimes falling as low as −9.5° C. No living algæ were reported above low water during the winter of 1908–9, all plants observed above this line appearing dead. While it is probable that more careful observation would show the presence of Lyngbya, Fucus, and possibly Gelidium and Gymnogongrus between the tide lines, nearly all the species undoubtedly have their upper limit determined, as in summer, by the height of the low tides.

In April and May many species occur above low water, but even at this time the majority are restricted to the zone below low tides. The vertical distribution of the species observed here at this time is as follows:

OCCURRING ONLY ABOVE LOW TIDE.

Lyngbya confervoides.
Leathesia difformis.
Porphyra leucosticta.
Gelidium coerulescens.
Gelidium crinale.

OCCURRING ONLY BELOW LOW TIDE.

Enteromorpha flexuosa.
Chætomorpha melagonium f. rupincola.
Cladophora flexuosa.
Bryopsis plumosa.
Ectocarpus confervoides.
Ectocarpus siliculosus.
Stilophora rhizodes.
Sargassum filipendula.
Agardhiella tenera.
Gracilaria multipartita.
Champia parvula.
Lomentaria uncinata.
Grinnellia americana.
Chondria dasyphylla.
Dasya pedicellata.
Polysiphonia nigrescens.
Ceramium strictum.

OCCURRING BOTH ABOVE AND BELOW LOW TIDE.

Enteromorpha linza.
Enteromorpha prolifera.
Ulva lactuca.
Petalonia fascia.
Fucus vesiculosus.
Bangia fusco-purpurea.
Gymnogongrus griffithsiæ.
Hypnea musciformis.
Chondria tenuissima.

It is worthy of note that Petalonia and Hypnea, which at other seasons are restricted to the zone below low water, now extend into the zone between the tide lines.

With the vertical distribution so limited, there is naturally little opportunity for the formation of distinct zones other than those occasioned by the growth of species above or below low water. While some species occur at slightly greater depths than others, the difference is so slight that it is scarcely capable of description.

HORIZONTAL.

The horizontal distribution is marked by a decrease in the number of both species and individuals as we go from the inlet in any direction, whether into the harbor, into Bogue Sound, or into Back Sound. The summer flora is the only one that has been studied in this connection. At this time the Fort Macon jetties bear a dense growth, Padina, Hypnea, and *Chondria dasyphylla* being the dominant forms, closely followed by Dictyota and Sargassum, bearing an abundance of Acrochætium and Herposiphonia, with Gymnogongrus, Codium, and *Gracilaria multipartita* occurring in considerable numbers and other species occasionally present. Between the jetties are numerous plants of Rosenvingea, *Chondria sedifolia*, and *Dermatolithon pustulatum* on eel grass (*Zostera marina*), while the innermost jetties bear an abundance of Fucus. *Lyngbya confervoides* and *Gelidium cærulescens* cover the rocks and shells between tide lines on the jetties and along the shore.

On Shackleford jetties the same species are found except that *Chondria dasyphylla* is lacking, probably because this brittle species is unable to endure the strong tidal currents found there. Padina is the dominant species at this place, occurring with Sargassum in great fields on the rocks in this clear water to a depth of 1.4 m. *Gracilaria multipartita* is more abundant than on Fort Macon jetties and *G. confervoides* is present in large numbers. Rosenvingea, Fucus, and *Chondria sedifolia* were not observed here. Many plants of Padina growing in the most brightly lighted situations were slightly but decidedly calcified, while the majority of the plants here and all of this species observed elsewhere lacked this deposit.

Along the shore from Fort Macon jetties to Bogue Sound no algæ were found, probably because of the lack of places suitable for attachment, since the conditions here appear especially favorable for algal growth.

Of the 77 species and varieties recorded for the harbor, 65 have been found growing on the jetties and buoys near the inlet; the 12 species not found here being as follows:

Chroococcus turgidus?
Hydrocoleum lyngbyaceum.
Lyngbya lutea.
Oscillatoria nigro-viridis.
Ulva fasciata.
Ulva lactuca var. latissima.
Chætomorpha linum.
Chætomorpha brachygona.
Bryopsis plumosa.
Ectocarpus duchassaingianus.
Stilophora rhizodes.
Laurencia tuberculosa var. gemmifera.

The following 21 species have been found growing only in the vicinity of the inlet:

Enteromorpha flexuosa.
Enteromorpha intestinalis.
Chætomorpha melagonium f. rupincola.
Cladophora crystallina.[a]
Rhizoclonium riparium.
Leathesia difformis.
Rosenvingea orientalis.
Dictyopteris polypodioides.
Spatoglossum schroederi.
Acrochætium dufourii.
Acrochætium parvulum.[a]
Eucheuma gelidium.
Rhodymenia palmetta.
Nitophyllum medium.
Herposiphonia tenella.
Polysiphonia harveyi.
Polysiphonia denudata.[a]
Callithamnion polyspermum.
Ceramium tenuissimum?
Grateloupia filicina.
Amphiroa fragilissima.

In the vicinity of the laboratory (on Pivers Island) a fairly large flora occurs along the shores, especially around this island and along the town front, 43 species and varieties having been found growing here, as follows:

Chroococcus turgidus?
Hydrocoleum lyngbyaceum.
Lyngbya confervoides.
Lyngbya lutea.
Enteromorpha linza.
Enteromorpha prolifera.
Ulva fasciata.
Ulva lactuca var. latissima.
Ulva lactuca var. rigida.
Chætomorpha linum.
Bryopsis plumosa.
Codium decorticatum.
Codium tomentosum.
Ectocarpus confervoides.
Ectocarpus siliculosus.
Ectocarpus mitchellæ.
Petalonia fascia.
Myrionema strangulans.
Stilophora rhizodes.
Fucus vesiculosus.
Sargassum filipendula.
Dictyota dichotoma.
Padina vickersiæ.
Erythrotrichia carnea.
Porphyra leucosticta.
Acrochætium hoytii.
Acrochætium virgatulum.
Acrochætium corymbiferum.
Gelidium cœrulescens.
Gymnogongrus griffithsiæ.
Agardhiella tenera.
Gracilaria confervoides.
Gracilaria multipartita.
Hypnea musciformis.
Champia parvula.
Lomentaria uncinata.
Grinnellia americana.
Chondria dasyphylla.
Chondria tenuissima.
Dasya pedicellata.
Polysiphonia nigrescens.
Ceramium strictum.
Dermatolithon pustulatum.

These algæ have been found especially north and southwest of Pivers Island, on the laboratory jetties and along the town front, apparently because these localities had more places suitable for attachment.

Records for other localities in this region have been obtained only for the summer. During this season algæ are scarce in the harbor beyond the vicinity of the laboratory. Along the shores of the marshes north of Pivers Island and north of Morehead City there have been found only four species, as follows:

Ulva lactuca var. latissima.
Fucus vesiculosus.
Gracilaria confervoides.
Hypnea musciformis.

No algæ were found in the water extending into the marshes. This water is very muddy, is scarcely affected by ordinary tides, and frequently is very hot.

[a] Found growing only on buoys.

In Newport River at "Green Rock," near the entrance to Core Creek, eight species were found as follows:

Ulva lactuca var. latissima.
Ectocarpus duchassaingianus.
Dictyota dichotoma.
Gelidium crinale.
Gracilaria multipartita.
Hypnea musciformis.
Laurencia tuberculosa var. gemmifera.
Polysiphonia sp.

In Bogue Sound, in the vicinity of Morehead City and on the north shore of Bogue Banks, the same conditions were found as were noted on the marshes north of Pivers Island, and a similar scarcity of algæ was observed. Owing to the difficulty of navigating here at low tide and the fact that conditions were so unfavorable for the growth of algæ, this sound was not explored further.

In North River near Lenoxville there were found six species, as follows:

Ulva lactuca var. latissima.
Ectocarpus mitchellæ.
Dictyota dichotoma.
Gracilaria confervoides.
Gracilaria multipartita.
Hypnea musciformis.

In Core Sound near Marshallberg, Lecklys Island, and Davis Island, there were found the following 10 species:

Ulva lactuca.
Dictyota dichotoma.
Erythrotrichia carnea.
Gelidium crinale.
Agardhiella tenera.
Hypnea musciformis.
Gracilaria confervoides.
Gracilaria multipartita.
Chondria sedifolia.
Dermatolithon pustulatum.

In Pamlico Sound at Ocracoke there were found the following 16 species:

Chroococcus turgidus?
Lyngbya semiplena.
Spirulina sp.
Enteromorpha prolifera.
Ulva lactuca.
Ulvella lens.
Gomontia polyrhiza.
Ectocarpus mitchellæ.
Acrochætium virgatulum.
Gelidium crinale.
Eucheuma gelidium.
Gracilaria multipartita.
Hypnea musciformis.
Chondria dasyphylla.
Spyridia filamentosa.
Dermatolithon pustulatum.

Although the records at places far from the laboratory were made from only one or two expeditions to these localities, they are believed to be fairly complete, since a thorough search was made at each place, and a second trip always verified the results obtained on a previous visit. The number of individuals at these places showed the same scarcity as the number of species.

It will be observed that *Ulva lactuca*, *Gracilaria confervoides*, *G. multipartita*, and *Hypnea musciformis* were most often present. No locality permitting the growth of any alga was found which did not bear at least three of these species.

The decrease in the algæ as we leave the inlet may, with considerable assurance, be ascribed to two factors, decreased density and increased turbidity. The former probably plays a part and may determine the limits of some of the species found only near the inlet, but the main factor limiting most of the species is undoubtedly the greatly increased turbidity. Even the parts of this region that have sandy and shelly bottoms have a thick covering of mud, and the water throughout the harbor and sounds is very turbid.

Many of the algæ growing in the localities noted above are covered with mud and have a pale, sickly appearance. Under such conditions it is not surprising that the number of species and individuals is small.

It is surprising, however, that the algæ were not more abundant in Pamlico Sound at Ocracoke. Here are several jetties and piles of shells that would seem to furnish excellent habitats for algæ. Ocracoke Inlet (leading directly to the open ocean) is only 2 km. away, and the water is not more turbid than around the laboratory in Beaufort Harbor; yet only 14 species were found there, the majority of the species that are dominant in Beaufort Harbor being entirely lacking. This scarcity may be due in part to the low density observed there, but further studies are needed to explain these facts.

The algæ collected in Newport River near "Green Rock" were, with the exception of Gelidium, mostly unattached. These seem to be plants that have been brought here by the tide and are continuing their existence floating near the bottom.

It is worthy of note that, with the exception of fragments of Enteromorpha, etc., on the sand breaks at Fort Macon and Shackleford, no algæ were ever observed during the summer growing on wood in Beaufort Harbor. Although there are numerous wharf, beacon, and railroad piles and two plank walls here with algæ attached to shells and stones near their bases, not a single specimen of algæ, not even Lyngbya, was ever found on these. In North River, Core Sound, and Pamlico Sound, on the contrary, there were found abundant Lyngbya and several plants of Enteromorpha, Ectocarpus, Dictyota, and Hypnea on the piles of wharves and beacons, and in the spring Enteromorpha, Porphyra, and other algæ grow abundantly on the wharf piles in Beaufort Harbor. The reason for this is not apparent, but it seems probable that it is caused by the crowding out of the algæ by sponges, barnacles, ascidians, and other animals which grow abundantly on these piles.

In no case have there been observed large numbers of animals and algæ growing together, the parts of both rocks and buoys which bear a conspicuous growth of algæ being comparatively free of animals and vice versa. Studies on this point would probably yield some interesting data.

OTHER LOCALITIES.

No extended studies have been made at any place other than Beaufort, but the observations made indicate that other localities, while differing considerably in detail, are affected by the same general factors as at Beaufort. With some exceptions the algæ are confined to the zone below low-tide line, they extend scarcely more than 90 cm. below low water, and they have to endure great turbidity. At no place, however, was there found anything approaching the number of species or of individuals observed at Beaufort. This seemed especially surprising in the case of Charleston, S. C., since a considerable number of species has been reported from this place by earlier collectors. Three days at different times during July and August were, however, spent in a careful search of this harbor, including James Island, Morris Island, Isle of Hope, and Isle of Palms, without revealing a large number of species or of individuals. While the records below were obtained from observations made on short visits to each place, they represent from one

to three days' work in each locality and are believed to give a fair representation of the algæ present at these times. The species and varieties found are as follows:

BANKS CHANNEL, MASONBORO SOUND, WRIGHTSVILLE BEACH, N. C.

Ulva lactuca.
Codium decorticatum.
Codium tomentosum.
Ectocarpus sp.
Rosenvingea orientalis.
Dictyota dichotoma.
Gracilaria confervoides.
Gracilaria multipartita.
Hypnea musciformis.
Champia parvula.
Herposiphonia tenella.
Melobesia sp.

SOUTHPORT, N. C.

Lyngbya sp.
Enteromorplia prolifera.
Ulva lactuca.
Cladophora fascicularis.
Gracilaria multipartita.
Bostrychia rivularis.

GEORGETOWN, S. C.

Undetermined Myxophyceæ.
Enteromorpha prolifera.
Ulva lactuca.

PAWLEYS ISLAND, NEAR GEORGETOWN, S. C.

Enteromorpha prolifera.
Codium decorticatum.
Codium tomentosum.
Gelidium crinale.
Hypnea musciformis (2 cm. long).
Grinnellia americana (1 cm. long).
Dasya pedicellata (1 cm. long).
Herposiphonia tenella.
Polysiphonia denudata? (2 cm. long).

CHARLESTON, S. C.

Chætomorpha linum.
Gelidium coerulescens.
Agardhiella tenera?
Gracilaria confervoides.
Gracilaria multipartita.
Grateloupia gibbesii.

PORT ROYAL, S. C.

Enteromorpha linza.
Enteromorpha prolifera.
Gracilaria multipartita var. angustissima.
Gracilaria confervoides.
Lomentaria uncinata.
Polysiphonia harveyi.
Polysiphonia denudata.

TYBEE, GA.

No algæ except undetermined Myxophyceæ on oyster shells.

METHODS FOR COLLECTING AND PRESERVING ALGÆ.

Many excellent specimens of algæ may be gathered from the beach, where they are thrown by the tides and waves, but satisfactory collections can be obtained only from the places where they are growing. Except in deep water, where the tide makes no appreciable difference, all collections should, of course, be made at low tide. The algæ are procured in three ways: Those growing between tide lines or near the surface are collected by hand; at a greater depth they may be gathered by long hooks, rakes, or tongs; while those growing at great depths are obtained by dredging. These three methods differ greatly in their relative values. Those stations which may be reached

by hand can be thoroughly searched in a relatively short time, while those which are at greater depths require repeated collections extending through several years before we can be reasonably sure of having a fair representation of the species growing there. Collins has aptly compared the collections of algæ obtained by dredging with those of other plants which might be gathered from a large field on a dark night by means of an aeroplane and a long rake. In clear, still water the use of a glass-bottom boat or bucket, enabling one to see the algæ which are growing at considerable depths, may be used to advantage, but in this region one can not see farther below the surface with a glass-bottom boat than without it.

The large, coarse algæ, which are more abundant farther north and are represented here only by Fucus, need no special care after being collected, but most other algæ are easily injured. These may be carried for a short time in an ordinary collecting can or other vessel that will protect them from the sun and keep them moist, but they should be placed in sea water as soon as possible, preferably as soon as they are collected. In any case, a large-mouthed bottle should be carried to hold the smaller, more delicate species that may be found.

Farther north, where the air temperature is much higher than that of the water, most algæ die soon after being gathered, since they can not endure the change of temperature to which they are exposed; but in this region algæ may be kept for days in jars of sea water, provided that they are clean and that very few specimens are placed in each jar.

For preservation, the algæ should be dried. Large, coarse species, as Fucus, may be dried between blotters under pressure or may even be spread out and allowed to dry in the air. In the latter case, however, it is difficult to make them lie flat when it is desired to mount them on paper. All other forms should be mounted on paper as soon as possible, any thick, unglazed paper being suitable for this. With the larger, more rigid, specimens, one may simply shake off the water and spread these out on the paper. The more delicate specimens should be floated in sea water, the paper slipped under them, and the algæ arranged on the paper, needles being used if necessary. The hand is then placed under the center of the paper, and this, bearing the specimen, is carefully removed from the water. The alga is then arranged on the paper in the position that shows it to greatest advantage, needles and water dropped carefully upon it from a pipette being most useful for this operation.

Having mounted the specimens, one should then dry them under moderate pressure between plant driers or blotters, first laying some thin, white cloth over the algæ to keep them from sticking to the driers. A very good plant press may be made from boards weighted with stones. The driers should be changed at least twice a day and should be thoroughly dry when used. Specimens should be kept in the press until all moisture is removed from them.

Microscopic forms should be mounted in such a way that they may be examined with the microscope, thin sheets of mica being good for this purpose. The brittle coralines are always difficult objects to handle. Some of them may be pressed flat while living and may then be fastened to paper by gummed tape. They should be kept in folders to preserve any fragments that may be broken off. Some minute algæ adhering closely to rocks can best be preserved by breaking off pieces of the rock on which they are growing. Any specimens that do not adhere to paper may be fastened on with gummed tape.

The above directions will serve as suggestions for beginners and will hold for the majority of species, while the experience and ingenuity of the collector will enable him to devise ways to handle the more difficult forms that may be found.

ECONOMIC USES OF ALGÆ.

From a utilitarian standpoint algæ are of value in four ways: (1) As food; (2) as a source of glue, gelatin, and agar-agar for jellies, culture media, and other purposes; (3) as a source of iodine, potassium, and other chemical substances; (4) as a fertilizer which may be applied directly to the soil.

Since the substances contained in algæ have little food value, their use as food must correspond to the use of green vegetables, such as spinach or lettuce, or of condiments. In this way they are used in large quantities and with great relish in other countries. Of the genera in this region, Enteromorpha, Ulva, Codium, Dictyota, Porphyra, Gracilaria, Hypnea, Chondria, and probably many others might be thus employed. Considerable information regarding the use of algæ for food and in other ways is given by Smith (1905), by Miss Reed (1907), and by Howe (1917).

It is well known that the "Irish moss," *Chondrus crispus*, of more northern shores may be used for the preparation of jelly and blancmange. Only one species, *Gracilaria confervoides*, has been tested here for this purpose, but from that species a very good jelly was obtained. The procedure is as follows: The plants of Gracilaria are cleaned, washed, bleached, and dried in the sun for several days, being repeatedly washed during this time with fresh water. The algæ is then heated in water for one or two hours to extract the gelatinizing substances and is strained. The resulting strained jelly is sweetened and flavored to taste, set in a cool place to harden, and is served with cream. Blancmange may be made in the same way, using milk instead of water. Other gelatinous algæ, as Gelidium, Agardhiella, and *Gracilaria multipartita*, probably could be used for this purpose in the place of *G. confervoides*.

No species of algæ occurs in this region in sufficient quantity to be of commercial value for the manufacture of gelatin or agar-agar, but on other portions of our coast gelatinous algæ occur in large numbers and probably could be utilized in this way. In the past agar-agar has been made principally in Germany from algæ obtained from Japan. It is probable that experiments would show that this could be made from algæ growing on our coasts, provided the proper algæ could be found in sufficient quantities.

The algæ used as sources of iodine and potassium are the rockweeds and kelps. Of these only Fucus occurs in this region, and this is not in sufficient quantities to be of value.

In the north the rockweeds and kelps furnish a valuable source of fertilizer, which, after rotting, may be applied directly to the soil. These algæ, with the exception of Fucus, are not found here, and no other species grows in the harbor in sufficient quantity to warrant its being gathered for this purpose. After hard storms, however, algæ are found on Bogue Beach in enormous masses, composed principally of Zonaria and Sargassum. If these were gathered and allowed to rot in the open, where they would be washed free of salt water, they would probably be found an excellent fertilizer and would supply the organic matter needed by a very sandy soil.

PART II. SYSTEMATIC ACCOUNT OF THE ALGÆ.

IDENTIFICATION OF ALGÆ.

The main groups of algæ are usually easily distinguished, since they differ markedly in their structure and usually in their color.

The Myxophyceæ, or "blue-green algæ," consist of cells of relatively simple structure living singly or joined into loose colonies or united into filaments; they are usually gelatinous and, as their common name implies, usually have a dark, blue-green color. By these characters they are easily distinguished from all others.

The Chlorophyceæ, or "green algæ," consist of single cells, filaments, sheets, or more complex structures. If the structures are complex, they are not composed of closely packed cells, but of interwoven filaments which are easily seen when teased apart and examined with slight magnification. They are light or dark yellow green, the color of grass and leaves, and are not likely to be mistaken for any other group. Some of them are encrusted with lime.

The Phæophyceæ, or "brown algæ," are easily distinguished by their brown color, which may, however, have the shade of walnut or mahogany, or may tend toward olive green. They consist of filaments or of more or less complex cellular structures.

The Rhodophyceæ, or "red algæ," consist of filaments, sheets, irregular aggregations, or complex cellular structures of various forms. They sometimes furnish difficulties to beginners, since their color and form are extremely various, the former ranging from red or pink to dark purple on the one side and to a decided green on the other. If green, they may be distinguished by the fact that their structure, at least in part, shows a close cellular arrangement and does not consist entirely of interwoven filaments. A still surer character for fertile specimens, once it has been recognized, is the fruit borne by all but the simplest members of this group. This is the cystocarp, which consists essentially of a mass of spores radiating from a common center and surrounded by a sterile jacket of some sort. This may be immersed and relatively inconspicuous but frequently forms more or less conspicuous conical projections above the surface. Even when immersed it is usually plainly seen as it is borne in a swollen part of the frond.

While, however, the main divisions are easily distinguished, the smaller groups often furnish considerable difficulty. Once they have been seen, the genera of the blue-green, green, and brown algæ may usually be easily recognized, or may even be identified with certainty from illustrations, but it is often difficult to place a given specimen of red algæ in its proper genus or even in its proper family or order. In many cases species of all the divisions are distinguished with great difficulty and only after careful study and comparison of many specimens. It can not be hoped, therefore, that the following descriptions will enable a determination to be made in every case. It should be borne in mind by a beginner that, while many forms may be recognized at a glance, others require much study and can be determined only when all the distinguishing characters are present. Frequently forms must be left undetermined because the material is not sufficient. One should, therefore, collect an abundance of every unknown species. In all cases it is desirable to compare the specimens with some that have been correctly determined, since one good specimen will convey a better idea of the species than it is possible to get from pages of description. Those using the keys given here should remember that these are made only for the species that have been found in this region, and if used in other regions or if other species should be found here, they may lead the beginner astray.

CLASSIFICATION AND DESCRIPTION OF SPECIES.

KEY TO DIVISIONS.

a. Thallus composed of single cells or of rather short filaments; multiplication purely vegetative, either by simple cell division or by means of hormogonia or gonidia; color usually blue-green..... I. MYXOPHYCEÆ (p. 407).

aa. Thallus composed of single cells, or filamentous, or forming tubes or sheets or complex structures of various shapes composed of closely interwoven filaments; multiplication asexual or sexual—asexual by fragmentation or by motile zoospores or by akinetes, sexual by similar or dissimilar motile or nonmotile gametes; color usually grass-green..... II. CHLOROPHYCEÆ (p. 417).

aaa. Thallus filamentous or forming complex structures of various shapes; multiplication asexual or sexual—asexual by motile biciliate zoospores or by aplanospores or by certain portions of the thallus, sexual by similar or dissimilar motile or nonmotile gametes, in some genera by distinct eggs and sperms; color usually brown, sometimes shading to yellowish or to olivaceous green..... III. PHÆOPHYCEÆ (p. 435).

aaaa. Thallus filamentous or forming sheets or complex structures of various shapes; multiplication asexual or sexual—asexual usually by nonmotile spores usually produced four in a sporangium, sexual by nonmotile male gametes (spermatia) and nonmotile female gametes remaining inclosed within special organs (carpogonia), usually with the association of special cells (auxiliary cells), a fruit of a special kind (cystocarp) usually being formed as the result of fertilization; color usually some shade of red, purple, or pink, sometimes green or blackish..... IV. RHODOPHYCEÆ (p. 462).

Division I. MYXOPHYCEÆ (Wallroth) Stizenberger.[a]

Myxophykea Wallroth, 1833, p. 4.
Chlorospermeæ, in part, Harvey, 1858, p. 1.
Myxophyceæ, Stizenberger, in Rabenhorst, 1860, p. 18.
Cryptophyceæ, Thuret, in Le Jolis, 1863, p. 13.
Cyanophyceæ, Sachs, 1874, p. 248.
Schizophyceæ, Cohn, 1879, p. 279.
Cryptophyceæ, Farlow, 1882, p. 26.
Myxophyceæ, Forti, in De Toni, 1907, p. 1.
Myxophyceæ, Tilden, 1910, p. 1.

BLUE-GREEN ALGÆ, FISSION ALGÆ.

Algæ typically blue-green, possessing within their cells endochrome composed of chlorophyll and a characteristic blue pigment; pigments of other colors sometimes present; endochrome diffuse, rarely gathered in large, sharply defined bodies. Thallus variable in form and size, unicellular or multicellular, sometimes having a peculiar motion; plants usually in gelatinous masses, sometimes solitary among other algæ. Multiplication purely vegetative; either by simple cell division in one, two, or three planes; or by means of hormogonia (multicellular fragments of the thallus, at first motile, afterwards coming to rest); or by means of nonmotile gonidia formed within gonidangia; or by means of resting gonidia (formed from ordinary cells). Algæ living for the most part in fresh or salt water, sometimes aerial, more rarely endophytic; the individual cells and filaments microscopic in size; sometimes brown, violet, gold, or reddish.

About 1,500 species described, representatives occurring in all parts of the world, at extreme variations of temperature.

[a] This group is often treated as a class under the division Schizophyta, which then includes the Myxophyceæ, or as they are sometimes called, the Schizophyceæ (the blue-green algæ), and the Schizomycetes (the bacteria).

This division, well represented in most regions, here forms a very small part of the marine flora, only 10 genera and 10 species having been obtained in quantities sufficient for determination.

KEY TO ORDERS.

Plants unicellular, single, or associated in families, which are usually surrounded by a gelatinous integument, not filamentous ..... 1. COCCOGONEÆ (p. 408).
Plants multicellular (except Spirulina), filamentous ..... 2. HORMOGONEÆ (p. 409).

Order 1. Coccogoneæ (Thuret) Kirchner.

Plants unicellular, single, or associated in families or colonies which are usually surrounded by a copious gelatinous integument, rarely forming filaments; multiplication occurs commonly by the vegetative division of cells, rarely by the formation of four or more nonmotile gonidia arising from the division of the contents of a cell (gonidangium).

Family 1. CHROOCOCCACEÆ Nægeli.

Cells solitary or associated in families, showing no difference between basal and apical regions; multiplication usually by simple division of the cells.

Unicellular algæ, entirely uniform, occurring singly or more often in clusters which are conspicuous even to the naked eye, the cells grouped without order in a common sheath. Cells spherical, oval or elongate, sometimes fusiform, cuneate, or squarish. Extremely minute bodies containing diffuse blue, æruginous, or even purple, olive, brown, or yellow coloring matter occur in the cells. The cell wall is sometimes thin and delicate, sometimes thick, often surrounded by a structureless, gelatinous sheath which holds the cells together for many generations and forms families variable in number and appearance of the cells. Divisions usually in three planes forming families irregularly grouped, but also in two planes forming layers of sheetlike families, or even in one plane, forming families at first linear, then by mechanical action irregularly grouped and contorted. Propagation in the Chroococcaceæ living singly does not occur except by the vegetative division of the cells, in those species living gregariously it occurs either by the separation of a single cell or by the splitting up of an old family into several families. Spores provided with a thickened resistant wall have been observed occasionally in species of Glœocapsa; these arise from the vegetative cells and are formed by the repeated division of the contents or by the dissolution of the membrane.

About 300 species, mostly in fresh water, less often in salt water or in damp places or aerial, throughout the world.

Genus Chroococcus Nægeli.

Chroococcus Nægeli, 1849, p. 45.

Cells globose, or by mutual pressure more or less angular, each surrounded by a more or less definite sheath; solitary or associated in families composed of two or four, rarely more, individuals, but not held together in definite colonies by a common gelatinous sheath; cell wall thin or wide, homogeneous or lamellose, colorless or colored; cell contents homogeneous or granular, æruginous or blue-green, sometimes yellowish or orange or violet; multiplication by successive division of the cells alternately in three planes; free floating or forming a gelatinous or crustlike mass in damp places.

Forty-eight species, mostly in fresh water or in damp places, some in salt water, some in the tissues of other plants; throughout the world.

Chroococcus turgidus (Kuetzing) Nægeli.

Protococcus turgidus, Kuetzing, 1845, tom. 1, pl. 6, f. 1.
Chroococcus turgidus, Nægeli, 1849, p. 46.
Chroococcus turgidus, Farlow, 1882, p. 27.
Chroococcus turgidus, Wolle, 1887, p. 334, pl. 210, f. 40–41.
Chroococcus turgidus, Forti, in De Toni, 1907, p. 11.
Chroococcus turgidus, Tilden, 1910, p. 5, pl. 1, f. 3.
P. B.–A. Nos. 751, 2202.

Cells spherical, oblong-elliptical, or more or less angular from mutual pressure, single or associated in families of two, four, rarely eight, 13 to 25, rarely 40 mic. in diameter; sheaths thick, usually lamellose, hyaline, cell wall thin, cell contents pale blue-green, homogeneous, later becoming brownish and granular.

On moist rocks and occasionally in salt marshes throughout the world.

Very abundant, with *Microcoleus chthonoplastes* and *Plectonema battersii* on ocean beach at Ocracoke, N. C. (?); covering many square meters just beyond high-tide line, August, 1907, on shells in Pamlico Sound; fairly abundant on rocks and shells and on *Gelidium cœrulescens*, Fort Macon and Duncan breakwater, Beaufort, N. C. (?), forming small masses not visible to the naked eye.

The material from Core Sound and from Beaufort seemed to belong to this species but occurred so scatteringly that it could not be obtained in sufficient quantity for a positive determination.

Order 2. **Hormogoneæ** (Thuret) Kirchner.

Nostochineæ, Farlow, 1882, p. 29.

Plants multicellular, rarely unicellular (Spirulina), filamentous, attached to a substratum or free floating; filaments simple or branched, usually consisting of one or more rows of cells within a sheath; multiplication occurs by means of hormogonia or resting gonidia.

KEY TO FAMILIES.

a. Filaments attenuated at apex, usually tapering to a hair; attached at base. . 4. RIVULARIACEÆ (p. 416).
aa. Filaments never tapering to a hairlike apex. . . . . *b*.
b. Filaments simple or branched, if branched having several or many trichomes within each sheath, heterocysts lacking. . . . . 1. OSCILLATORIACEÆ (p. 409).
bb. Filaments simple, heterocysts present. . . . . 2. NOSTOCACEÆ (p. 414).
bbb. Filaments (or trichomes) regularly branched, having only one trichome within the sheath, heterocysts present. . . . . 3. SCYTONEMACEÆ (p. 415).

Family 1. OSCILLATORIACEÆ (Gray) Kirchner.

Trichomes simple, composed of similar vegative cells, rarely unicellular, usually surrounded by a sheath; filaments simple or rather sparsely branched, containing one or more trichomes; filaments and trichomes rarely occurring scattered, usually forming scum, membranes, mats, etc.; propagation by hormogonia; no heterocysts.

Usually blue-green, less often violet or brownish, rarely red. Cells usually short-cylindrical or disk-shaped; less often barrel-shaped, in Spirulina long cylindrical and spirally twisted. Apical cell rounded or wedge-shaped, sometimes calyptrate, sometimes tapering slightly. Filaments usually straight, often curved or spirally twisted at the apices, in certain genera spirally twisted throughout the entire length. Often several trichomes occur within a single more or less coarse sheath, forming a single filament. Sheaths sometimes delicate and inconspicuous, sometimes coarse, even exceeding the diameter of the trichome; walls of sheaths sometimes very firm, sometimes gelat-

inous, so that they adhere together very easily. Propagation occurs by hormogonia—longer or shorter fragments of trichomes, breaking out the sheaths and moving of themselves by circumnutation in the water, then, the movement ceasing, sheaths are formed and cell division commences. In the genera without sheaths—e. g., Oscillatoria, Spirulina—the movements persist throughout their life.

The Oscillatoriaceæ inhabit principally moist, aerated places; many live in water containing decaying organic matter; some are incrusted with calcium carbonate; some thrive in temperatures as high as 85° C.

About 550 species throughout the world.

The members of this family are usually easily distinguished in that they do not taper to long hairs at the apices, they lack heterocysts, and in the majority of cases are unbranched. The only species found in this region that is likely to be wrongly identified as belonging to this family is *Plectonema battersii*, one of the Scytonemaceæ. This species lacks hairlike apices and heterocysts and might easily be taken for one of the branching Oscillatoriaceæ. From these it can be easily distinguished by the fact that it has only one trichome within a sheath, while both Hydrocoleum and Microcoleus have several or many trichomes within each sheath.

KEY TO GENERA.

a. Sheaths absent.....*b*.
b. Trichomes straight or nearly so, multicellular.....1. Oscillatoria (p. 410).
bb. Trichomes forming a regular spiral, unicellular.....2. Spirulina (p. 411).
aa. Sheaths present.....*c*.
c. Filaments consisting of one trichome within each sheath, simple.....*d*.
d. Sheaths swollen, gelatinous, filaments more or less agglutinated.....3. Phormidium (p. 411).
dd. Sheaths not swollen, firm, filaments free or forming a tangled mat, not agglutinated.....4. Lyngbya (p. 411).
cc. Filaments consisting of several trichomes within a single sheath, simple or branched.....*e*.
e. Filaments consisting of few trichome swithin a single sheath, trichomes often loosely aggregated.....5. Hydrocoleum (p. 413).
ee. Filaments consisting of numerous trichomes within a single sheath, trichomes densely aggregated, often twisted into ropelike bundles.....6. Microcoleus (p. 413).

Genus 1. **Oscillatoria** Vaucher, ex Gomont.

Oscillatoria, Vaucher, 1803, p. 165.
Oscillaria, Farlow, 1882, p. 32.
Oscillatoria, Gomont, 1892, tome 16, p. 198.

Trichomes cylindrical, free, usually motile, without a sheath or rarely inclosed in a very thin, fragile, mucous sheath, sometimes constricted at the joints, not moniliform, often attenuated at the apices, straight or curved or more or less regularly corkscrew-shaped in some species, but not constantly spiral; outer wall of apical cell thickened in some species, forming a calyptra.

About 100 species in fresh or salt water, sometimes in hot springs or on moist earth, throughout the world.

Oscillatoria nigro-viridis Thwaites, ex Gomont.

Oscillatoria nigro-viridis, Thwaites, in Harvey, 1851, pl. 251a.
Oscillaria limosa var. *chalybea*, Farlow, 1882 p. 33.
Oscillatoria nigro-viridis, Gomont, 1892, tome 16, p. 217, pl. 6, f. 20.
Oscillatoria nigro-viridis, Forti, in De Toni, 1907, p. 161.
Oscillatoria nigro-viridis, Tilden, 1910, p. 69.
P. B.-A. No. 1056.

Plant mass very dark olive green; trichomes moderately long, rather straight, fragile, constricted at joints, arcuate toward the extremities, tapering and obtuse at the apices, 7 to 11 mic. in diameter, cells 3 to 5 mic. long; apical cell somewhat capitate with convex and slightly thickened outer wall; transverse walls granulated, cell contents pale green or olive.

Maine to West Indies; Washington; Europe; Australia.

Several large masses floating in harbor, August, 1909, in sparse tufts on marine grasses, shoals west of laboratory, and near "Green Rock," Beaufort, N. C.

A few other specimens belonging to this genus have been found at Beaufort in small quantities on shells or marine plants, or growing directly on sandy shoals between tide lines, but none has been obtained in sufficient quantity for a specific determination.

Genus 2. **Spirulina** Turpin, ex Gomont.

Spirulina, Turpin, 1827, tome 50, p. 309.
Spirulina, Gomont, 1892, tome 16, p. 249.

Trichomes unicellular, thin, cylindrical, without a sheath, forming a regular, rather loose or close spiral, having a characteristic spiral movement; apex not tapering, cell contents homogeneous or slightly granular.

Twenty-one species in fresh or salt water, gathered into a continuous layer or scattered among other algæ, in America, Europe, Africa, and Australia.

A few filaments of an undetermined species of Spirulina were found on shells in Pamlico Sound at Ocracoke, N. C.

Genus 3. **Phormidium** Kuetzing, ex Gomont.

Phormidium, Kuetzing, 1843, p. 190.
Phormidium, Gomont, 1892, tome 16, p. 156.

Filaments showing evident sheaths, unbranched, agglutinate, usually forming a felt-like mat with free ends torn and ragged, attached at the base or rarely floating; sheaths thin, transparent, mucous, adhering to each other, partly or entirely diffluent; trichomes constricted at the joints in some species, sometimes even becoming moniliform, straight or curved but never regularly spiral, often tapering toward the apices, outer wall of apical cell thickened, in some species, to form a calyptra.

About 70 species, usually terrestrial or in fresh water, some species marine.

Many filaments of an alga apparently belonging to this genus, but insufficient for specific determination, were found on the hydroids inhabited by *Acrochætium infestans* growing on *Dictyota dichotoma* dredged from the coral reef offshore, August, 1914. These filaments had trichomes 0.75 to 1.5 mic. in diameter with cells 0.75 to 3.0 (mostly 1 to 2) diameters long, and were closely adherent to the stalks and rhizomes of the hydroids.

Genus 4. **Lyngbya** Agardh, ex Gomont.

Lyngbya, Agardh, 1824, p. XXV.
Lyngbya, Gomont, 1892, tome 16, p. 116.

Filaments possessing evident sheaths, free, unbranched, free floating, or forming a densely intricate floccose or expanded mass; sheaths firm, of variable thickness, sometimes lamellose, colorless or rarely yellow brown; trichomes sometimes constricted at the joints, obtuse or slightly tapering at the apices, outer wall of apical cell sometimes thickened, forming a calyptra.

Seventy-five species in fresh or salt water throughout the world.

KEY TO SPECIES.

Trichomes 9 to 25 mic. in diameter, cells 2 to 4 mic. long; sheaths up to 5 mic. thick, colorless, later becoming lamellose; apex not tapering, no calyptra, transverse walls usually granulated.....1. *L. confervoides* (p. 412).

Trichomes 5 to 12 mic. in diameter, cells 2 to 3 mic. long; sheaths up to 3 mic. thick, colorless, lamellose with age; apex slightly tapering, furnished with calyptra, transverse walls frequently granulated.....2. *L. semiplena* (p. 412).

Trichomes 2.5 to 6 mic. in diameter, cells 1.5 to 5.5 mic. long; sheaths thin, colorless, later becoming thick and lamellose; apex not tapering, furnished with calyptra, transverse walls usually not distinct.....3. *L. lutea* (p. 413).

1. **Lyngbya confervoides** Agardh, ex Gomont.

Lyngbya confervoides, Agardh, 1824, p. 73.
Lyngbya confervoides, Harvey, 1858, p. 103, pl. 47c.
Lyngbya nigrescens, Harvey, 1858, p. 102, pl. 47d.
Lyngbya luteo-fusca, Farlow, 1882, p. 35 (excluding synonyms).
Lyngbya confervoides, Gomont, 1892, tome 16, p. 136, pl. 3, f. 5-6.
Lyngbya confervoides, Forti, in De Toni, 1907, p. 271.
Lyngbya confervoides, Tilden, 1910, p. 119, pl. 5, f. 39.
A. A. B. Ex. No. 48 (L. luteo-fusca).
P. B.-A. Nos. 255, 1106.

Plant mass about 5 cm. in height, forming extensive mats or an intricate ragged mass, fasciculate, mucous; dull yellowish or dark green, sometimes violet when dry; filaments tangled, long, straight, somewhat rigid, ascending from a decumbent base; sheaths up to 5 mic. thick, colorless, later becoming lamellose and roughened on the surface; trichomes not attenuated at the apices, not constricted at the joints, 9 to 25 mic. in diameter, cells 2 to 4 mic. long, apical cell rotund, no calyptra; transverse walls usually granulated; cell contents olive or blue-green.

Maine to Florida; Nebraska; West Indies; warm and temperate waters everywhere.

Very abundant on rocks and shells along town front, especially on Duncan breakwater, very abundant on rocks of Fort Macon jetties, and less abundant on rocks of Shackleford jetty, Beaufort, N. C. Forms the uppermost zone of algæ occurring up to the median high-tide line, sometimes mixed with minute specimens of Cladophora, Chætomorpha, and Enteromorpha, sometimes forming pure growths over large areas. April to October, probably throughout the year. This is the only species belonging to the Myxophyceæ that has been found at Beaufort in sufficient quantity to be conspicuous.

2. **Lyngbya semiplena** (Agardh) J. Agardh, ex Gomont.

Calothrix semiplena, Agardh, 1827, p. 634.
Lyngbya semiplena, J. Agardh, 1842, p. 11.
Lyngbya semiplena, Gomont, 1892, tome 16, p. 138, pl. 3, f. 7-11.
Lyngbya semiplena, Forti, in De Toni, 1907, p. 273.
Lyngbya semiplena, Tilden, 1910, p. 118, pl. 5, f. 38.
P. B.-A. Nos. 5, 1059, 1452.

Plant mass rarely beyond 3 cm. in height, forming extensive mats, mucous; usually dull yellowish or dark green, becoming dark violet when dry; filaments ascending from a decumbent tangled base, soft, flexuous; sheaths up to 3 mic. thick, colorless, somewhat mucous, lamellose with age; trichomes slightly attenuated at the apices, not constricted at the joints, 5 to 12 mic. in diameter, cells 2 to 3 mic. long, apical cell bearing a depressed conical or rotund calyptra, transverse walls frequently granulated.

Maine to North Carolina, probably farther; Nebraska; Washington; California; Mexico; West Indies; Hawaii; Atlantic and Mediterranean shores of Europe.

Very abundant, forming extensive mats almost covering posts of wharf and beacon between tide lines, mixed with other Myxophyceæ, Ocracoke, N. C.

3. **Lyngbya lutea** (Agardh) Gomont, ex Gomont.

Oscillatoria lutea, Agardh, 1824, p. 68.
Lyngbya tenerrima, Farlow, 1882, p. 35.
Lyngbya juliana, Wolle, 1887, p. 301, pl. 202, f. 20–21.
Lyngbya lutea, Gomont, 1890, p. 354.
Lyngbya lutea, Gomont, 1892, tome 16, p. 141, pl. 3, f. 12–13.
Lyngbya lutea, Forti, in De Toni, 1907, p. 275.
Lyngbya lutea, Tilden, 1910, p. 114, pl. 5, f. 30–31.
P. B.-A. No. 854.

Plant mass somewhat gelatinous, leathery, yellowish brown, or olive, often becoming dark violet when dry; filaments coiled, flexible, densely entangled; sheaths colorless, smooth, at first thin, later becoming thick (up to 3 mic.) and lamellose; trichomes not constricted at the joints, not tapering at the apices, 2.5 to 6 mic. in diameter, cells 1.5 to 5.5 mic. long, apical cell showing a rotund calyptra, transverse walls usually not distinct, cell contents granular, olive green.

Maine to Florida and Alabama; West Indies; Europe; Dalmatia; northern Africa.

In sparse tufts on marine grasses, shoals west of laboratory, Beaufort, N. C., August, 1907.

Genus 5. **Hydrocoleum** Kuetzing, ex Gomont.

Hydrocoleum, Kuetzing, 1843, p. 196.
Hydrocoleum, Gomont, 1892, tome 15, p. 332.
Hydrocoleus, Forti, in De Toni, 1907, p. 315.
Hydrocoleus, Tilden, 1910, p. 134.

Filaments possessing evident sheaths, forming heaped or indefinite masses, or layers not massed, giving a tangled mat, very rarely hardened with lime; sheaths always colorless, cylindrical, somewhat lamellose, more or less mucous or somewhat formless and entirely dissolving on the older filaments; trichomes few within the sheath, often loosely aggregated, more or less false branching, apex of trichome straight, more or less attenuated, outer membrane of apical cell thickened into a calyptra, cells shorter than the diameter of the trichome, in some species very short.

Twenty species in fresh and salt water throughout the world, mostly marine.

Hydrocoleum lyngbyaceum Kuetzing, ex Gomont.

Hydrocoleum lyngbyaceum, Kuetzing, 1849, p. 259.
Lyngbya arenarium, Wolle, 1887, p. 299, pl. 201, f. 27–29.
Hydrocoleum lyngbyaceum, Gomont, 1892, tome 15, p. 337, pl. 12, f. 8–10.
Hydrocoleus lyngbyaceus, Forti, in De Toni, 1907, p. 317.
Hydrocoleus lyngbyaceus, Tilden, 1910, p. 135, pl. 5, f. 58.
P. B.-A. Nos. 204, 205.

Dark green mats or a broadly expanded gelatinous layer; filaments adnate, unbranched at base, branched in upper portions, false branches numerous, somewhat appressed; sheaths wide, mucous, containing one or more trichomes, roughened in outline, acuminate or often open at apex, sometimes entirely dissolved and agglutinated; trichomes 8 to 16 mic. in diameter, not constricted at the joints, numerous at the base of the filaments, spirally twisted and entangled, solitary in the branches, cells 2.5 to 4.5 mic. long, apex of trichome attenuated, truncate, transverse walls granulated.

Massachusetts to Florida; Bermuda; West Indies; warm and temperate waters generally.

Fairly abundant on *Gelidium cœrulescens*, Duncan breakwater, Beaufort, N. C., forming small tufts 1 to 2 cm. long tangled in the upper branches of the host.

Genus 6. **Microcoleus** Desmazieres, ex Gomont.

Microcoleus, Desmazieres, 1823, p. 7.
Microcoleus, Gomont, 1892, tome 15, p. 350.

Filaments possessing evident sheaths, simple or vaguely branched; sheaths colorless, more or less regularly cylindrical, not lamellose, in some species finally dissolving; trichomes many within a sheath, closely crowded, often twisted into ropelike bundles in well-developed filaments, apex of trichome straight, attenuated, apical cell acute, rarely obtusely conical, capitate in one species.

Thirteen species in fresh or salt water or on the ground, sometimes growing among other algæ, throughout the world.

Microcoleus chthonoplastes (Mertens) Thuret, ex Gomont.

Conferva chthonoplastes, Mertens, in Flora Danica, 1818, Fasc. 27, p. 8, pl. 1485.
Microcoleus chthonoplastes, Thuret, 1875, p. 378.
Microcoleus chthonoplastes, Farlow, 1882, p. 33, pl. 2, f. 3.
Microcoleus gracilis, Wolle, 1887, p. 306, pl. 203, f. 10–11.
Microcoleus anguiformis, Wolle, 1887, p. 306.
Microcoleus chthonoplastes, Gomont, 1892, tome 15, p. 353, pl. 14, f. 5–8.
Microcoleus chthonoplastes, Forti, in De Toni, 1907, p. 371.
Microcoleus chthonoplastes, Tilden, 1910, p. 155, pl. 6, f. 28.
P. B.-A. Nos. 153, 906, 1854.

Filaments forming a dull or dark green, ragged, spreading, compact, stratified mass, made up of layers of different colors, or growing sparsely among other algæ; tortuous, not often branched; sheaths cylindrical, unequally roughened on the surface, with apex usually open, sometimes entirely dissolving; trichomes blue-green, short, nearly straight, many within the sheath, usually densely aggregated into bundles, rarely twisted into cords, constricted at the joints, 2.5 to 6 mic. in diameter, cells 3.6 to 10 mic. long, apex of trichome attenuated, apical cell not capitate, acutely conical, transverse walls not granulated.

Canada to North Carolina; Texas; Ohio; Illinois; Dakota; Washington; West Indies; warm and temperate waters generally.

Very abundant with *Chroococcus turgidus* and *Plectonema battersii* on ocean beach at Ocracoke, N. C., covering many square meters just beyond high-tide line, August, 1907.

Family 2. NOSTOCACEÆ (Agardh) Kirchner.

Nostochaceæ, Forti, in De Toni, 1907, p. 383.

Trichomes simple, consisting of similar vegetative cells, not differentiated into basal and apical regions, not tapering to hairs at the apices, usually provided with heterocysts, naked or inclosed in a mucous, gelatinous, or membranaceous sheath; multiplication by gonidia and hormogonia.

Usually æruginous—green. Trichomes straight or twisted or curved, of equal diameter throughout or tapering very slightly toward the apices, heterocysts terminal or intercalary. Sheaths usually gelatinous, often dissolving into an inclosing jelly, often adhering to each other, more rarely membranaceous and cylindrical, colorless or yellowish or olivaceous, containing one or more trichomes.

The Nostocaceæ live on moist earth, among mosses, etc., often in quiet fresh water, sometimes in rapid streams, sometimes in salt or brackish water, a few being endophytic.

About 220 species throughout the world.

Genus **Microchæte** Thuret, ex Bornet and Flahault.

Microchæte, Thuret, 1875, p. 378 (7).
Microchæte, Bornet and Flahault, 1887, p. 83.

Filaments possessing evident sheaths, unbranched, erect, attached at the base, solitary or forming small cushionlike tufts; trichomes single within the sheath, hetorocysts basal or intercalary, gonidia formed near the base.

Eleven species, all minute, in fresh or salt water, widely distributed.

Microchæte nana Howe and Hoyt. Pl. CXVII, figs. 12–17.

Microchæte nana, Howe and Hoyt, 1916, p. 105, pl. 12, figs. 12–17.

Plants inconspicuous, almost microscopic, forming loose, scattered clusters over the surface of the host; filaments mostly 0.1 to 0.2 mm. long, curved near base or near middle, usually more or less horizontal toward the base and erect toward the apex, sometimes almost prostrate throughout or almost

erect throughout, tapering very slightly toward the apices; sheath very thin, delicate, scarcely visible; trichomes light olivaceous (?), 5.0 to 8.3 mic. in diameter, slightly constricted at the septa toward apex, scarcely so below, cells 1 to 3 (mostly 1.5–2) times as broad as long, the apical ones broadly dome-shaped or almost hemispheric; heterocysts basal, usually single, rarely double, subspherical or ovoid, 5.0 to 6.6 mic. in diameter, or sometimes 8.3 mic. long, gonidia unknown.

Endemic.

Few patches of scattered filaments on *Dictyota dichotoma* dredged from the coral reef offshore from Beaufort, N. C., August, 1914.

This species will not be mistaken for any other occurring in this region. It has been found only the one time noted.

Family 3. SCYTONEMACEÆ (Kuetzing) Rabenhorst.

Scytonemataceæ, Kirchner, in Engler and Prantl, 1900, p. 76.

Trichomes composed of a single row of cells, one or more included within a sheath, not ending in a hair at the apex; filaments branched, false branches formed by the perforation of the sheath by the trichome which thereupon issues as one or two long, flexuous branches, each developing a sheath of its own; sheaths homogeneous and colorless, or lamellose and yellowish or brownish, firm, tubular, sometimes incrusted with lime; heterocysts and gonidia variously distributed, sometimes lacking; multiplication by means of vegetative division, hormogonia, and gonidia.

Filaments usually forming tufted masses, sometimes matted or ragged layers. Vegetative cells cylindrical or barrel-shaped, rarely spherical, apex hemispherical or semiellipsoid, cell contents blue-green or sometimes violet or rose-red. Filaments nearly uniformly thick at all points, and always with false branching; false branches always occur in connection with the heterocysts, when these are present, going out either immediately below a heterocyst or midway between two of these, the latter method giving a pair of branches. Heterocysts present except in Plectonema, subspherical, oval, or cylindrical, at the bases of the branches or intercalary in the filaments, single or several adjoining, always attached to the inner wall of the sheath.

About 150 species, mostly aerial or on moist earth or in fresh water, throughout the world.

Genus **Plectonema** Thuret, ex Gomont.

Plectonema, Thuret, 1875, p. 375.
Plectonema, Gomont, 1892, tome 16, p. 96.

Filaments free or forming feltlike masses, branched, false branches solitary or in pairs; sheaths firm, colorless or rarely yellowish orange; trichomes frequently constricted at the joints, apex of trichomes straight, very rarely attenuated, calyptra none, heterocysts and gonidia none.

Twenty-one species, mostly in fresh water, rarely on soil, few in salt water, America, Europe, Asia.

Plectonema battersii Gomont.

Plectonema battersii, Gomont, 1899, p. 36.
Plectonema battersii, Forti, in De Toni, 1907, p. 495.
Plectonema battersii, Tilden, 1910, p. 211.
P. B.-A. No. 1060.

Plant mass blackish or brownish green; filaments elongate, flexuous, abundantly and repeatedly branched, false branches usually in pairs, more slender than the main filaments; sheaths colorless, somewhat thick in the main filaments; trichomes 2 to 3.5 mic. in diameter, constricted at joints, with

somewhat attenuated apices, apical cell rotund, cells up to four times shorter than diameter, cell contents homogeneous, pale blue-green.

Maine; Massachusetts; England; Norway.

Very abundant with *Chroococcus turgidus* and *Microcoleus chthonoplastes* on ocean beach at Ocracoke, N. C., covering many square meters just beyond high-tide line, August, 1907.

This is the most southern station reported for this species.

Family 4. RIVULARIACEÆ (Meneghini) Kirchner.

Filaments tapering from base to apex, terminating above in a colorless hair, simple or branched, associated in brushlike or gelatinous layers, rarely solitary; false branches due to development of a new trichome from a cell of the main trichome, usually occurring immediately under an intercalary heterocyst, rarely by the perforation of the sheath between two heterocysts by the trichome, either separating immediately and forming a new sheath, or remaining for some time within the original sheath; heterocysts usually present, usually basal, occasionally intercalary; multiplication by vegetative division and hormogonia, sometimes by gonidia.

The apical cells always seem nearly empty and are usually colorless; the basal cells show blue-green, violet, red, or brownish cell contents. Sheaths cylindrical, gelatinous or membranaceous, homogeneous or stratose, colorless, yellowish or brownish. The sheaths are often split by apical elongation into superposed lamina; often the inner sheaths, becoming dissolved, pass out from the apex; often incrusted with lime. Hormogonia are situated at the apices of the filaments and branches and, the apical hairs being shed, pass out from the apices. To this is due the fact that the older filaments sometimes lack the apical hairs. In some genera Chroococcus-like masses are formed at the base from the vegetative cells and later grow into filaments.

About 170 species, in fresh and salt water, throughout the world.

Genus **Dichothrix** Zanardini, ex Bornet and Flahault.

Dichothrix, Zanardini, 1858, p. 297.
Dichothrix, Bornet and Flahault, 1886, p. 373.

Plant mass cæspitose, penicillate, or pulvinate, filaments more or less dichotomously branched; sheaths cylindrical, trichomes often several (2 to 6) inclosed in a common sheath, heterocysts sometimes basal, sometimes intercalary, in one species not present, no gonidia.

Thirteen species in fresh or salt water, America, Europe, Africa.

Dichothrix penicillata Zanardini, ex Bornet and Flahault.

Dichothrix penicillata, Zanardini, 1858, p. 297, pl. 14, f. 3.
Dichothrix penicillata, Bornet and Flahault, 1886, p. 379.
Dichothrix penicillata, Forti, in De Toni, 1907, p. 644.
Dichothrix penicillata, Tilden, 1910, p. 280.
P. B.-A. Nos. 62, 1112.

Plant mass cæspitose, fastigiate-penicillate, scattered or clustered, dark green; filaments short, flexuous, 2 mm. long, 25 to 35 mic. diameter (in ultimate branches); sheaths thick, gelatinous, soft, uniform, colorless; trichomes 15 mic. broad; cells shorter than diameter, cell contents olive, heterocysts oblong, solitary.

Florida; Mexico; West Indies; Guadeloupe; Red Sea.

Covering a considerable portion of one piece of *Sargassum natans*, Bogue Beach, Beaufort, N. C., June 29, 1907; one small tuft (8 to 10 filaments) on one piece of *Chondria littoralis*, Bogue Beach, September 19, 1906. (?)

The last-mentioned tuft seemed to belong to this species, but contained too few filaments for a positive determination. This is the most northern station reported for this species.

In addition to the species described above, members of the Myxophyceæ were observed in more or less abundance at Marshallburg, N. C.; Southport, N. C.; Georgetown, S. C.; and Tybee, Ga.; but the material from these places proved indeterminable or, for various reasons, has not been determined.

Division II. CHLOROPHYCEÆ (Kuetzing, in part) Wittrock.

Chlorospermeæ, in part, Harvey, 1858.
Zoosporeæ, in part, Farlow, 1882.
Oosporeæ, in part, Farlow, 1882.

Green Algæ.

Algæ chlorophyll green (rarely red, yellowish, or brownish, sometimes grayish from deposits of lime), containing pure chlorophyll in their cells (rarely mixed with other pigments); chlorophyll confined to definitely limited bodies, the chloroplasts. Thallus consisting of one or more cells, simple or branched, filiform or of various shapes, filamentous, membranaceous, or tubular. Multiplication asexual or sexual: asexual (propagation) by the fragmentation of the entire plant or of some part, or by noncopulating motile cells (zoogonidia, zoospores, swarm spores), or by resting cells (akinetes, aplanospores); sexual (reproduction) by at least eventually nonmotile zygotes (zygospores, oospores) formed by the copulation or conjugation of gametes free of membranes; gametes similar (isogametes), or different in form, size, etc., that is, male and female (heterogametes), motile or nonmotile.

The members of this group live mostly in water, either salt or fresh, while some occur on moist soil and some are endophytic. The akinetes and aplanospores are formed from vegetative cells. Zoospores are formed either from ordinary vegetative cells or from special cells, zoosporangia; they are pear-shaped, bear two or four, less often one or many, cilia on their anterior, pointed, colorless end, and often have a red eyespot and contractile vacuole; they come to rest after a longer or shorter time, develop a membrane, and usually develop immediately into new plants. Zygotes are formed in one of three ways: (1) By the copulation of two motile gametes, exactly alike or differing slightly in size; (2) by the fertilization of a large nonmotile female gamete (egg) by a small motile male gamete (sperm); (3) by the copulation or conjugation of two nonmotile gametes similar in appearance. The similar gametes are formed from ordinary cells; eggs and sperms are developed in special organs, oogonia and antheridia. The zygote, in some cases, develops immediately into a new plant, but in the majority of forms, after a period of rest, develops swarm spores, which, after swimming about, come to rest and grow into new plants.

There is no other group of algæ about which there is so much difference of opinion concerning the classification. The name Chlorophyceæ is here used in a broad sense, including the Heterokontæ, Stephanokontæ, Conjugatæ, etc., of other authors. There seems to be need for a name covering this assemblage of forms which seem to show more or less close relationship to each other. For these it has seemed desirable to retain the old, inclusive name, at least until some uniformity of opinion can be reached regarding their division. In this scheme the divisions of other authors (Conjugatæ, Heterokontæ, etc.) would be subdivisions under Chlorophyceæ.

Nearly 3,000 species; throughout the world.

KEY TO ORDERS

a. Frond usually of relatively large size, multinucleate, without division into cells.....3. SIPHONALES (p. 430).
aa. Frond divided into cells.....*b*.
b. Cells uninucleate, chromatophore usually single, disk or net-shaped.....1. ULOTRICHALES (p. 418).
bb. Cells multinucleate, chromatophore net-shaped, or of numerous small disks in a cell .....2. SIPHONOCLADIALES (p. 423).

Order 1. **Ulotrichales.**

Confervoideæ, in part, De Toni, 1889.
Confervoideæ, in part, Wille, in Engler and Prantl, 1897.

Simple or branched filaments, sometimes membranes, rarely in few-celled families; cells uninucleate, rarely multinucleate; chromatophore usually single, band, disk, net, or star shaped, generally with one or more pyrenoids. Marine and fresh water.

KEY TO FAMILIES.

Frond membranaceous, either flat or forming a tube.....1. ULVACEÆ (p. 418).
Frond filamentous, branching, or a few-celled family; usually with hairs...2. CHÆTOPHORACEÆ (p. 422).

Family 1. ULVACEÆ (Lamouroux) Rabenhorst.

Membranaceous, plane, or tubular fronds; cells uninucleate, with disk-shaped chromatophores and one pyrenoid; asexual propagation by four-ciliate zoospores (sometimes biciliate?); sexual reproduction by similar biciliate gametes.

Near the base of the frond the cells may send down rhizoidal prolongations to the substratum, often uniting to form a thickened stipe; otherwise than this there is no specialization of cells. Zoospores or gametes may be formed in any cell of the frond except the lowest cells. The zygospore formed by the fusion of two gametes, after a short period of motility with four cilia, settles down, loses its cilia, surrounds itself by a membrane, and develops immediately into a new plant, forming a filament or small sack which soon changes into the characteristic form of the frond.

About 100 species, mostly marine, rarely in fresh water, mostly in the littoral zone throughout the world from Arctic to Antarctic regions.

KEY TO GENERA.

Frond tubular or flattened; simple or branched.....1. Enteromorpha (p. 418).
Frond flat, often forming extensive sheets.....2. Ulva (p. 420).

Genus 1. **Enteromorpha** Link.

Enteromorpha, Link, 1820, p. 5.
Ulva enteromorpha, Farlow, 1882, p. 43.

Frond originating in a single series of cells, which by repeated division form a tubular frond (sometimes flattened), the membrane of which consists of a single layer of cells; in some of the simpler species the tubular stage is not reached, and the frond in the adult state consists of two or a few series of cells, united without any interior space; simple or branched; cells often arranged in longitudinal series. All the cells of the frond, except the lowest, capable of producing zoospores or gametes, which are discharged through an opening in the cell wall.

Frond always attached at first, later often free floating. The genus is connected with Ulva by *E. linza*, in which the tube is compressed and the membranes united in the middle part.

Thirty species, usually in salt or brackish water, occasionally in fresh water, throughout the world.

The specific distinctions are founded chiefly on the manner of branching and on the size and arrangement of the cells and are often difficult of determination.

KEY TO SPECIES.

a. Frond flat, the membranes free at the margins, but united between.....4. *E. linza* (p. 420).
aa. Frond tubular.....*b.*
b. Cells not arranged in longitudinal series except in the very youngest parts.....
.....3. *E. intestinalis* (p. 420).
bb. Cells more or less in longitudinal series, usually in the greater part of the frond.....*c.*
c. Fronds simple, inflated, and flexuous.....2. *E. flexuosa* (p. 419).
cc. Fronds regularly branched.....1. *E. prolifera* (p. 419).

1. **Enteromorpha prolifera** (Flora Danica) J. Agardh.

Ulva prolifera, Flora Danica, vol. 5, fasc. 14, p. 7, pl. 763, fig. 1, 1832.
Enteromorpha prolifera, J. Agardh, 1882, p. 129, pl. 4, figs. 103–104.
Enteromorpha prolifera, De Toni, 1889, p. 122.
Enteromorpha prolifera, Collins, 1909, p. 202.
P. B.-A. Nos. 470, 610, 913.

Frond up to several meters long and 2 cm. in diameter, tubular or compressed, with more or less abundant branches which are usually simple, but sometimes also proliferous; branches varying much in length and diameter; cells 10 to 12 mic., in the younger parts always arranged in longitudinal series, which become less distinct in the older parts; membrane 15 to 18 mic. thick, not much exceeding the dimensions of the cells in cross section.

Greenland to West Indies; Alaska to California; Europe.

Beaufort, N. C.: Abundant throughout winter 1908–1909; very abundant May, 1907, and April, 1908, on rocks, shells, and piers throughout harbor and at Fort Macon and Shackleford, extending from about 10 cm. below low water to high-water line; very abundant at water line on sea buoy and channel buoy at entrance to Beaufort Harbor, July, 1909; abundant on rocks and sand breaks at Shackleford and Fort Macon between tide lines throughout summer (?). Cape Lookout beach, very abundant on old wreck about 20 m. from water at low tide, August, 1906. Pamlico Sound, Ocracoke, N. C., fairly abundant on posts of beacon between tide lines (?). Southport, N. C., very abundant on wall and shore, August, 1909. Georgetown, S. C., very abundant on jetty and shells on beach. Pawleys Island, near Georgetown, S. C., abundant on shells in bay near inlet. Port Royal, S. C., fairly abundant on buoy at water line.

This seems to be the only species of Enteromorpha occurring in this region throughout the year. Specimens collected in December are 3 to 4 cm. long, densely matted with many upright, filiform or club-shaped branches; in April and May this species is, next to *Ulva lactuca*, the most abundant in the harbor; the specimens at this time are 3 to 45 cm. long; in summer, material apparently belonging to this species is found as small, stunted tufts, 1 to 2 cm. long, on rocks and sand breaks near the inlet, this condition continuing as late as October or November. With the exception of these stunted representatives and of specimens occasionally growing on buoys, etc., this species has not been found here during the summer or autumn.

In habit this species is very variable, from slender, slightly branched forms, only a few centimeters long, to rich and repeatedly branched fronds; delicate or coarse; branches sometimes long and slender, sometimes short and very densely set, sometimes long and short intermingled quite without order. It also occurs in fresh water and about salt springs.

2. **Enteromorpha flexuosa** (Wulfen) J. Agardh.

Conferva flexuosa, Wulfen, in Roth, 1800, p. 188.
Enteromorpha flexuosa, J. Agardh, 1882, p. 126.
Enteromorpha flexuosa, De Toni, 1889, p. 121.
Enteromorpha flexuosa, Collins, 1909, p. 203.
P. B.-A. Nos. 462, 2004.

Frond cylindrical, tubular, simple, tapering to a filiform stipe below, above inflated, flexuous, and intestinelike; cells 6 to 8 by 8 to 12 mic., roundish polygonal, in longitudinal series; membrane somewhat thickened on the inside; chromatophore filling the thick-walled cell.

Florida; southern California; warmer waters generally.

Two or three small clumps, on rocks of Shackleford jetty, Beaufort, N. C., April, 1908. Fronds 6 to 23 cm. long.

This, being a southern species, might be expected to occur at Beaufort throughout the summer, but has been found only once, in April. Even then it was by no means a conspicuous part of the spring flora. It is distinguished from *E. intestinalis*, which it resembles, by having smaller cells arranged in regular series, a somewhat more delicate membrane, and a thicker wall between the cells.

3. **Enteromorpha intestinalis** (Linnæus) Link.

Ulva intestinalis, Linnæus, 1755, p. 432.
Enteromorpha intestinalis, Link, 1820, p. 5.
Enteromorpha intestinalis, Harvey, 1858, p. 57 (in part).
Ulva enteromorpha var. *intestinalis*, Farlow, 1882, p. 43.
Enteromorpha intestinalis, Wolle, 1887, p. 107, pl. 125, f. 9–10.
Enteromorpha intestinalis, De Toni, 1889, p. 123.
Enteromorpha intestinalis, Collins, 1909, p. 204.
P. B.-A. No. 464.

Frond simple or having at the base a few branches similar to the main frond, or occasionally a few proliferations above; length varying from a few centimeters to several meters; diameter 1 to 5 cm.; at first attached by a short, cylindrical stipe, but soon detached and floating; cylindrical or expanding above, more or less inflated, often much crisped and contorted, and irregularly and strongly constricted; cells 10 to 16 mic. in diameter, in no regular order; thickness of membrane varying from 50 mic. below to 20 mic. above; cells in cross section 12 to 30 mic.

Along the shores of North America, except, possibly, the south Atlantic coast; salt water lakes of western United States; Brazil; Europe; Japan.

Fairly abundant on rocks of Fort Macon jetties, Beaufort, N. C., December, 1908.

A very variable species, of which many forms have been described; some of these in fresh water.

4. **Enteromorpha linza** (Linnæus) J. Agardh.

Ulva linza, Linnæus, 1753, vol. 2, p. 1163.
Ulva linza, Harvey, 1858, p. 59.
Enteromorpha linza, J. Agardh, 1882, p. 134, pl. 4, f. 110–112.
Ulva enteromorpha var. *lanceolata*, Farlow, 1882, p. 43.
Enteromorpha linza, De Toni, 1889, p. 124.
Enteromorpha linza, Collins, 1909, p. 206.
P. B.-A. Nos. 16, 967.

Frond lanceolate or linear lanceolate, simple, 1 to 5 dm. long, 1 to 20 cm. broad; stipe short, hollow; upper part of the frond flat, the membranes grown together as in Ulva, except at the edges, where they remain free.

Maine to West Indies; Alaska to California; South America; Europe; Tasmania.

Abundant on rocks and shells in harbor and on jetties at Fort Macon and Shackleford, Beaufort, N. C., March to May, 1907–1909, at about low-water line; fairly abundant at about water level on buoy, Port Royal, S. C., August, 1909.

The forms of this species have been divided under forma *crispata*, with edges much crisped and folded, and forma *lanceolata*, edges even or folded, not crisped. Only the latter of these occurs at Beaufort. The smaller specimens look like forms of *E. intestinalis*, but in the latter the frond, though often collapsed, is tubular throughout; in *E. linza* the two membranes adhere except at the edges, where there is a narrow, open space, around which the cells are arranged in cross section nearly in a circle. Different plants vary greatly in their appearance, but the species is easily recognized by the above characters.

Genus 2. **Ulva** Linnæus.

Ulva, Linnæus, 1753, vol. 2, p. 1163.

Frond membranaceous, flat, consisting of two layers of cells, in any of which, except those in the thickened base, zoospores or gametes may be formed, issuing through an opening in the surface of the fronds, attached or free floating; surface entire or perforate.

Marine.

Seven species, some of them grading into each other, throughout the world.

KEY TO SPECIES.

Frond entire or irregularly lobed or laciniate.....1. *U. lactuca* (p. 421).
Frond divided into distinct segments.....2. *U. fasciata* (p. 422).

1. **Ulva lactuca** Linnæus.

Ulva lactuca, Linnæus, 1753, vol. 2, p. 1163.
Ulva latissima, Harvey, 1858, p. 59.
Ulva lactuca var. *lactuca*, Farlow, 1882, p. 43.
Ulva lactuca, De Toni, 1889, p. 111.
Ulva lactuca, Collins, 1909, p. 214, pl. 7, f. 75.

SEA LETTUCE.

Frond very variable in shape, at first attached and generally of a lanceolate or ovate-lanceolate form; later of irregular shape and often detached and floating; the cells usually vertically elongate in cross section, seen from the surface, irregularly angular, closely set; thickness of the frond very variable. In all seas.

Beaufort, N. C.: Abundant on rocks and on other algæ, Fort Macon and Shackleford jetties, throughout the year, usually not more than 2 to 4 cm. tall; abundant on Bogue Beach after winds; large pieces occasionally floating in the harbor, at times becoming fairly abundant; extremely abundant throughout harbor and on Fort Macon and Shackleford jetties, April and May, attached and floating, often up to 1 m. long; abundant in Newport River near Green Rock, August, 1906, forming large sheets resting on the bottom; and extremely abundant North River off Lennoxville, July, 1906, floating in large masses along shore. Pamlico Sound, Ocracoke, N. C.: Very abundant on shells, August, 1907. Core Sound, on jetty at Davis Island: Abundant, about 2 to 3 cm. tall. Wrightsville Beach, N. C.: Fairly abundant on shells in sound, July, 1909. Southport, N. C.: Very abundant, August, 1909. Georgetown, S. C.: Fairly abundant, August, 1909.

A very common plant throughout the world and extremely variable in form, thickness, and color. Two fairly marked types can be distinguished in the species as found with us on both Atlantic and Pacific coasts, connected by innumerable forms.

Var. **rigida** (Agardh) Le Jolis.

Ulva rigida, Agardh, 1820, p. 410 (in part).
Ulva lactuca, a *rigida*, Le Jolis, 1863, p. 38.
Ulva lactuca var. *rigida*, Farlow, 1882, p. 42.
Ulva lactuca forma *rigida*, De Toni, 1889, p. 111.
Ulva lactuca var. *rigida*, Collins, 1909, p. 215.
P. B.-A. Nos. 407, 2064.

Frond at first lanceolate or ovate; lanceolate, firm and stiff, with a distinct stipe; later somewhat irregularly divided, and often with numerous perforations of various sizes; cells vertically elongate in cross section.

Var. **latissima** (Linnæus) De-Candolle.

Ulva latissima, Linnæus, 1753, vol. 2, p. 1163.
Ulva lactuca var. *latissima*, De-Candolle, in Lamarck and De-Candolle, 1805, tome 2, p. 9.
Ulva lactuca var. *latissima*, Farlow, 1882, p. 43.
Ulva lactuca forma *genuina*, De Toni, 1889, p. 111.
Ulva lactuca var. *latissima*, Collins, 1909, p. 215.
P. B.-A. Fasc. D, No. LXXVI.

Frond irregular in outline, soon becoming detached and passing most of its life in a floating condition; thinner than var. rigida, lighter colored, and with cells nearer square in cross section.

Both of these forms seem to occur at Beaufort, but are not sharply distinguishable. In the immediate vicinity of Beaufort this species, like the species of Enteromorpha, reaches its greatest development in the spring months. At other times of the year it is present mostly in the form of specimens 2 to 4 cm. long attached to rocks. Large masses are, however, found in summer in adjoining waters and occasionally occur in Beaufort Harbor.

Many forms of the species approach closely in appearance to *U. fasciata* and slightly to *Enteromorpha linza*.

2. **Ulva fasciata** Delile.

Ulva fasciata, Delile, 1813, p. 153, pl. 58, f. 5.
Ulva fasciata, Harvey, 1858, p. 58.
Ulva fasciata, De Toni, 1889, p. 114.
Ulva fasciata, Collins, 1909, p. 216.
P. B.-A. No. 221.

Frond divided into more or less linear segments, margin smooth or undulate; in cross section the two layers of cells separate somewhat at the margin, which is rounded, with a small open space between the rows.

Florida; West Indies; California; warm waters all over the world.

Abundant in warm water of tide pool, northwest corner of "Town Marsh," Beaufort, N. C., resting on the bottom, summer.

A variable species varying from forms with a central axis and lateral lobes (as in a pinnately compound leaf) to forms having almost a continuous sheet with lobes few and inconspicuous, sometimes dichotomous; frond more or less perforate; lobes 5 mm. to 5 cm. in width; margin smooth and even or much crisped and undulate. (In this last form it corresponds to forms of *Enteromorpha linza*.) The structure of the frond is similar to that of *U. lactuca*, except the margin, which resembles *E. linza*. On the California coast it is hard to draw the line between this species and *U. lactuca*, either from the shape of the frond or from its structure. Four forms have been distinguished there, passing into each other more or less.

At Beaufort the species is easily distinguished by the much-crisped, lobed thallus with decidedly undulate margins, and by the structure of the frond at the margins. It forms sheets of considerable extent, with lobes long or short, broad or narrow, much crisped and much perforate. No specimens have been found with decidedly pinnate lobes like some of those occurring on the California coast. Some specimens approach forma *lobata* (P. B.-A. No. 863), but are more crisped and ruffled. Many lobes are long and narrow and much ruffled, resembling forma *tæniata* (P. B.-A. No. 862). The species has been observed at Beaufort only in summer; its condition at other times of the year is unknown. This is the most northern station reported for the species on our Atlantic coast, and is probably its northern limit.

Family 2. CHÆTOPHORACEÆ Wille.

Ulotrichiaceæ, De Toni, 1889, p. 151 (in part).

Fronds filamentous, except in a few doubtful forms, usually much branched, sometimes united in disklike expansions; cells uninucleate, with band-shaped or disk-shaped chromatophore, often somewhat divided or with projections; with one, rarely more pyrenoids; hairs almost always present, but varying in character; asexual propagation by four ciliate, in some cases biciliate, zoospores, by aplanospores, akinetes, and with special Palmella and Schizomeris stages in many genera; sexual reproduction in many genera by gametes, similar to the zoospores.

About 150 species, mostly fresh water, some marine, few aerial, etc., throughout the world.

A family of doubtful limits, being differently defined by nearly every author. The present treatment follows that of Collins (1909). The methods of reproduction seem to vary in different members, but are imperfectly known in the majority of cases.

KEY TO GENERA.

Genus 1. **Endoderma** Lagerheim.

Endoderma, Lagerheim, 1883, p. 75.
Entoderma, Wille, in Engler and Prantl, 1897, p. 94.

Frond microscopic, creeping on or within other algæ or aquatic plants; filaments irregularly branched, with or without hairs; cell division mostly terminal; chromatophore a parietal layer with one or more pyrenoids; zoospores 2 to 4 ciliate, with stigma, formed four or more in a cell, escaping by a hole and soon germinating; sexual reproduction by biciliate motile gametes without stigma is probable, but not certain.

About 10 species, marine and fresh water.

Endoderma viride (Reinke) Lagerheim.

Entocladia viridis, Reinke, 1879, p. 476, pl. 6, f. 6–9.
Endoderma viride, Lagerheim, 1883, p. 75.
Endoderma viride, De Toni, 1889, p. 209.
Endoderma viride, Collins, 1909, p. 279.
P. B.-A. Nos. 1626, 2006, 2236.

Filaments usually much branched, 3 to 8 mic., usually 6 mic. diameter, cells 1 to 6 diameters long, sometimes cylindrical, more often irregularly swollen and contorted, with one pyrenoid; terminal cell blunt or tapering; growing in cell walls of various algæ.

Massachusetts; Europe.

Fairly abundant on each of four specimens of *Cladophora catenata* (?), Bogue Beach, Beaufort, N. C., August, 1907.

This species seems to have been recorded in North America only from Massachusetts. Its small size makes it easily overlooked, and it will probably be found widely distributed on the Atlantic coast.

Genus 2. **Ulvella** Crouan.

Ulvella, Crouan, 1859, p. 288.

Fronds forming small disks on larger plants or other objects, firmly attached by the under surface, originally monostromatic, of radiating, laterally united, dichotomous filaments; later polystromatic except at the margin; cells with parietal chromatophore and, in most species, one pyrenoid, arranged in more or less definite vertical series; biciliate zoospores formed in the central cells, 4 to 8 to 16 in a cell, escaping by an opening at the top. Marine.

Few (4 or more) species in North America and Europe.

Ulvella lens Crouan. Fig. 1.

Ulvella lens, Crouan, 1859, p. 288, pl. 22, f. 25–28.
Ulvella lens, De Toni, 1889, p. 148.
Ulvella lens, Collins, 1909, p. 286, pl. 11, f. 102.

Fronds orbicular, 1 to 3 mm. diameter, cells 15 to 20 mic. in diameter in center of frond, near the margin 10 to 15 by 20 to 30 mic., without pyrenoid; frond usually not over three layers thick in the center.

West Indies; Europe.

Occasionally forming a green coating on shells, Pamlico Sound, Ocracoke, N. C., August, 1907.

Except for a recent find by Börgesen in the Danish West Indies, this species is not recorded from any other locality in North America.

Order 2. **Siphonocladiales.**

Fronds multicellular, usually more or less branched; cells multinucleate, very rarely uninucleate, chromatophore net shaped, or of numerous small disks.

KEY TO FAMILIES.

Frond erect, zoospores and gametes produced in little changed vegetative cells.....
.....1. CLADOPHORACEÆ (p. 424).
Frond creeping, boring in shells, zoospores produced in distinct, ultimately detached sporangia.....2. GOMONTIACEÆ (p. 429).

Family 1. CLADOPHORACEÆ (Hassall) De Toni.

Frond of simple or branching, monosiphonous filaments, free or more or less united laterally; cells multinucleate, rarely uninucleate, with chromatophore net form, or broken into many small portions, with many pyrenoids; asexual propagation by four ciliate zoospores (sometimes by biciliate?) and by akinetes; sexual reproduction by biciliate, usually similar gametes. Zoospores and gametes formed in little changed vegetative cells.

About 350 species, marine and fresh water, throughout the world.

KEY TO GENERA.

a. Filaments simple, firm.....*b.*
b. Filaments regularly cylindrical or clavate.....1. Chætomorpha (p. 424).
bb. Filaments usually more or less irregular.....2. Rhizoclonium (p. 427).
aa. Filaments branched.....*c.*
c. Branches usually short, rhizoidal.....2. Rhizoclonium (p. 427).
cc. Branches of successive orders, but of the same character.....3. Cladophora (p. 427).

Genus 1. **Chætomorpha** Kuetzing.

Chætomorpha, Kuetzing, 1845a, p. 203.

Frond of a single unbranched series of multinucleate cells, all but the usually longer basal cell capable of division; basal cell producing either a disk or more or less branched rhizoidal prolongations serving for attachment; frond always attached, or becoming loose and continuing in a free state; membrane thick, firm, usually distinctly lamellate; asexual propagation by four-ciliate zoospores, produced in little changed cells; sexual reproduction by similar biciliate gametes; akinetes sometimes formed (?).

About 50 species, mostly marine, rarely in fresh water, throughout the world from Arctic to Antarctic regions.

KEY TO SPECIES.

Filaments usually 400 to 500 mic. diameter, sometimes less, Beaufort material 120 to 240 mic.; coarse, wiry.....1. *C. melagonium* (p. 424).
Filaments 125 to 400 mic. diameter, sometimes less, usually 200 to 250 mic., Beaufort material 80 to 110 mic.; yellowish green, soft, flaccid.....2. *C. linum* (p. 425).
Filaments 125 to 175 mic. diameter, Beaufort material 100 to 175 mic.; dark green, soft, flaccid.....3. *C. brachygona* (p. 426).

1. **Chætomorpha melagonium** (Weber and Mohr) Kuetzing. Fig. 2C.

Conferva melagonium, Weber and Mohr, 1804, p. 194, pl. 3, f. 2.
Chætomorpha melagonium, Kuetzing, 1845a, p. 204.
Chætomorpha melagonium, Harvey, 1858, p. 85.
Chætomorpha melagonium, Farlow, 1882, p. 46.
Chætomorpha melagonium, De Toni, 1889, p. 273.
Chætomorpha melagonium, Collins, 1909, p. 323.
P. B.-A. No. 412 (forma *typica*), No. 413 (forma *rupincola*).

Filaments erect, coarse and wiry, dark glaucous green, usually 400 to 500 mic. diameter; sometimes 300 mic. or less; cells 1 to 2 diameters long.

Common from New Jersey to Greenland; Alaska; northern Europe.

Abundant on rocks Shackleford jetty, Beaufort, N. C., forming dense masses with *Ulva lactuca*, *Enteromorpha prolifera*, and *E. linza*, about low-water level, May, 1907.

Two forms of the species are recognized: f. *rupincola* (Areschoug) Kjellman, growing attached and erect, usually quite straight; and f. *typica* Kjellman, unattached, lying loose in crisped, tangled masses. The latter form is apparently only a later stage of the plant. There is considerable variation in the size of the filaments, and the slender forms, sometimes as low as 300 mic. diameter or less, are not always easy to distinguish from *C. linum;* but the greater rigidity and the dark, glaucous, green color are usually sufficient marks.

The material from Beaufort is finer and less rigid than most specimens of this species from other localities, approaching in this respect *C. linum*, but is coarser and more rigid than most specimens of the latter species. The comparative width of the filaments is as follows: *C. melagonium*, 180 to 440 mic.; *C. linum*, 142 to 434 mic.; *C. melagonium* (Beaufort specimens), 120 to 240 mic. Both of the former have length of cells from slightly less than 1 to more than 2 diameters, the Beaufort specimens have length of cells from two-thirds to 2 diameters, the majority of cells being 1 diameter or less. In spite of these variations, there seems little doubt that the material from Beaufort belongs to this species, forma *rupincola*. It is easily distinguished from *C. linum* at Beaufort by its coarse, rigid, dark-green filaments.

It has been found at this place only in May, 1907, not being observed in April, 1908. This is a northern species, and the present locality is the most southern station reported for it. It is not improbable that this is its southern limit, although it may be found farther south in the winter or spring.

2. **Chætomorpha linum** (Mueller) Kuetzing.

Conferva linum, Mueller, in Flora Danica, tom. 5, p. 4, pl. 771, f. 2, 1782.
Chætomorpha linum, Kuetzing, 1845a, p. 204.
Chætomorpha sutoria, Harvey, 1858, p. 87.
Chætomorpha longiarticulata, Harvey, 1858, p. 86, pl. 46, E.
Chætomorpha olneyi, Harvey, 1858, p. 86, pl. 46, D.
Chætomorpha linum, Farlow, 1882, p. 47.
Chætomorpha linum, De Toni, 1889, p. 269.
Chætomorpha aerea f. *linum*, Collins, 1909, p. 325.
Chætomorpha linum, Collins, 1918, p. 79.
A. A. B. Ex. No. 175.
P. B.-A. Nos. 22, 1863 (*C. aerea* f. *linum*).

Filaments unattached, prostrate, light green, rather stiff, diameter 200 to 250 mic., cells about as long as broad.

Nova Scotia to West Indies; warm and temperate waters generally.

Rather rare, shoal south of laboratory, Beaufort, N. C., August, 1903 (?); marsh west of laboratory, August, 1907 (?).

This species apparently bears the same relation to *C. linum* f. *aerea* as the loose form of *C. melagonium* does to the attached form. It occurs in great masses of curled and crisped filaments in warm, shallow bays.

The Beaufort material probably belongs to this species, but was not found in sufficient quantity for a positive determination.

Forma **aerea** (Dillwyn) Collins. Fig. 2A.

Conferva aerea, Dillwyn, 1809, pl. 80.
Chætomorpha aerea, Kuetzing, 1849a, p. 379.
Chætomorpha aerea, Harvey, 1858, p. 86.
Chætomorpha aerea, Farlow, 1882, p. 46.
Chætomorpha aerea, De Toni, 1889, p. 272.
Chætomorpha aerea, Collins, 1909, p. 324, pl. 12, f. 115.
Chætomorpha linum f. *aerea*, Collins, 1918, p. 79.
P. B.-A. Nos. 76, 1526 (C. aerea).

Filaments attached, erect, yellowish green, 125 to 400 mic. or less in diameter, cells about as long as broad, base of filament usually more slender than the upper part; when producing zoospores the fertile cells are much inflated and nearly globular.

Maine to West Indies; California; warm and temperate waters generally.

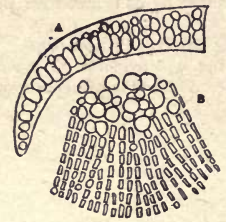
Sometimes abundant on rocks between jetties at Fort Macon, summer and autumn, forming flaccid, tangled masses of filaments about 6 dm. above low water, and fairly abundant on sea buoy, September, 1905, Beaufort, N. C. Abundant on rocks in tide pool, Morris Island, 10 cm. above to 10 cm. below water level, water warm to touch, Charleston, S. C.

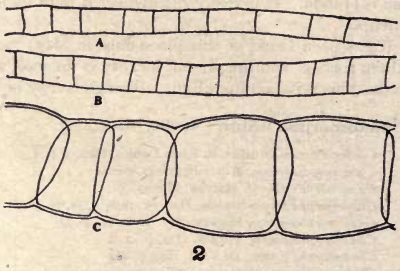
In habit like *C. melagonium*, but of somewhat smaller diameter, lighter color and softer texture; not firm enough to stand erect when taken from the water.

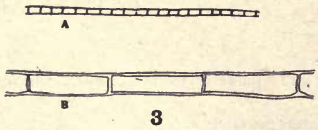
Of varying degrees of coarseness. The Beaufort material is finer than specimens from other localities, being 80 to 110 mic. wide, with cells 90 to 225 mic. long. In characters other than the size of the filaments, this material seems to agree with "*C. aerea*," as observed in herbaria, and is certainly more

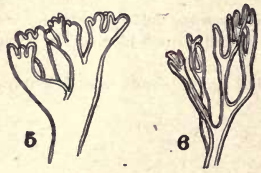
like that species than like any of the others recorded from North America. This is the finest of the three representatives of this genus occurring at Beaufort.

It seems somewhat irrational to consider a floating plant as the species and to refer the more natural, attached plant to a form. As was pointed out by Howe (1914, p. 99) this procedure is, however, required by the rules of botanical nomenclature, since *C. linum* was described before *C. aerea* and must, consequently, take precedence over the latter form.









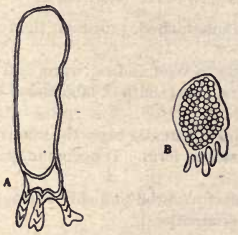


Fig. 1.—*Ulvella lens*, after Crouan (1859). A, Section of thallus; B, Surface view.

Fig. 2.—A, *Chætomorpha linum* f. *aerea;* B, *Chætomorpha brachygona;* C, *Chætomorpha melagonium* f. *rupincola.* ×47.

Fig. 3.—*Rhizoclonium riparium.* A, ×47; B, ×281.

Fig. 4.—*Gomontia polyrhiza*, after Lagerheim (1885). A Vegetative cell; B, Aplanosporangium.

Fig. 5.—*Udotea cyathiformis*, ×78, after Howe (1909). Apices of cortical filaments of stipe.

Fig. 6.—*Udotea conglutinata*, ×78, after Howe (1909). Apices of cortical filaments of stipe.

3. Chætomorpha brachygona Harvey. Fig. 2B.

Chætomorpha brachygona, Harvey, 1858, p. 87, pl. 46a.
Chætomorpha brachygona, De Toni, 1889, p. 267.
Chætomorpha brachygona, Collins, 1909, p. 325.
P. B.-A. No. 622.

Filaments free, rigid, curved, and twisted, forming strata of some extent on rocks or among other algæ; cells 125 to 175 mic. diameter, quite uniformly as long as broad, except just after dividing.

Florida; West Indies; Mexico.

Rather abundant, mixed with other algæ floating in harbor, Beaufort, N. C., September and October, 1905; large, tangled mass Bogue Beach, September, 1906.

The material from Beaufort Harbor has the diameter of filaments 100 to 175 mic. This species, as it occurs there, is intermediate in appearance between *C. melagonium* and *C. linum* f. *aerea*, being finer, less rigid, and lighter green than the former, and coarser, more rigid, and darker green than the latter.

This is the most northern station reported for the species, and is probably its northern limit.

Genus 2. **Rhizoclonium** Kuetzing.

Rhizoclonium, Kuetzing, 1843, p. 261.

Filaments usually prostrate, consisting of a single series of multinucleate cells, with net-shaped chromatophore and several pyrenoids, unbranched or, in some species, with a few irregular branches similar to the axis, and with more or less numerous rhizoidal branches, which are mostly unicellular, but sometimes consist of several cells. Asexual propagation by biciliate zoospores, with stigma, escaping through an opening in the cell wall; also by akinetes; but in only a few species has either form of fructification been found.

About 25 species, in fresh or salt water or on moist earth, throughout the world.

The filaments resemble those of Chætomorpha, but are less uniformly cylindrical, there being almost always more or less irregularity in the form of the cells. The short rhizoidal branches, when present, clearly characterize the genus, but they are not always developed, and when they are absent, the resemblance to Chætomorpha is deceptive.

Rhizoclonium riparium (Roth) Harvey. Fig. 3.

Conferva riparia, Roth, 1806, p. 216.
Rhizoclonium riparium, Harvey, 1849, pl. 238.
Rhizoclonium riparium, Harvey, 1858, p. 92.
Rhizoclonium riparium, Farlow, 1882, p. 49, pl. 3, f. 2.
Rhizoclonium riparium, De Toni, 1889, p. 278.
Rhizoclonium riparium, Collins, 1909, p. 327.
A. A. B. Ex. No. 213.
P. B.-A. Nos. 24, 1734 (266,976, var. *implexum;* 1688, var. *validum*).

Filaments usually pale green, forming expansions on ground or rocks in the littoral zone; cells usually 20 to 25 mic. in diameter, rarely a little more or less, length 1 to 2 diameters; branches none or few or many.

Greenland to Florida; Alaska to Washington; California; South America; Europe; Borneo.

Fairly abundant on rocks of Shackleford jetty, Beaufort, N. C., April, 1908.

Three varieties are recognized, depending on the amount and nature of the branching; there is no typical form distinct from these.

It was not observed here in May, 1907, and has not been found in winter or summer.

Genus 3. **Cladophora** Kuetzing.

Cladophora, Kuetzing, 1843, p. 262.

Frond composed of filaments of a single series of cells, the filaments branching, usually abundantly; branching lateral, but often coming to appear dichotomous in consequence of the pushing aside of the original filament by the branch; attached at first, later attached or free floating; growth chiefly by division of the apical cell, subsequent division of cells being exceptional; branches all of the same type; cells multinucleate, the chromatophore either covering the cell wall or forming a network on it or broken into numerous small disks; pyrenoids several in a cell; asexual propagation by four-ciliate zoospores; sexual reproduction by similar biciliate gametes, uniting and germinating immediately, or sometimes germinating without copulation; portions of filaments sometimes capable of passing into resting condition, forming structures perhaps to be considered as akinetes.

Three hundred to 400 species described, many of them on insufficient characters, occurring in fresh and salt water throughout the world.

One of the largest genera of algæ and one of the most difficult. There are few sharply marked characters for distinguishing the species, it being mostly a question of more or less in one respect or another. It is impossible for one not familiar with the genus to determine the species without abundant authentic specimens for comparison.

KEY TO SPECIES.

a. Main filaments seldom reaching 150 mic. in diameter ..... *b.*
b. Main filaments distinctly angled or flexuous ..... 1. *C. flexuosa* (p. 428).
bb. Main filaments straight or nearly so ..... 2. *C. crystallina* (p. 428).
aa. Main filaments 150 mic. or more in diameter ..... *c.*
c. Lower cells less than 10 diameters long ..... 3. *C. fascicularis* (p. 428).
cc. Lower cells 10 diameters long or more ..... 4. *C. prolifera* (p. 429).

1. **Cladophora flexuosa** (Mueller) Harvey.

Conferva flexuosa, Mueller, in Flora Danica, tom. 5, pl. 882, 1782.
Cladophora flexuosa, Harvey, 1849a, p. 202.
Cladophora flexuosa, Harvey, 1858, p. 78.
Cladophora flexuosa, Farlow, 1882, p. 54.
Cladophora flexuosa, De Toni, 1889, p. 311.
Cladophora flexuosa, Collins, 1909, p. 339.
A. A. B. Ex. No. 206.
P. B.-A. Nos. 1076, 1527, 2239.

Fronds 10 to 20 cm. high, light green; main filaments 80 to 120 mic. diameter, regularly flexuous with flexuous alternate branches, 40 to 80 mic. in diameter, with alternate or secund, curved, and sometimes refracted ramuli; cells from 6 diameters long below to 2 diameters in the ramuli.

Newfoundland to Bermuda and Florida; Alaska; Europe.

Abundant, attached and floating masses, Mullet Pond, Shackleford Banks, and fairly abundant on rocks of Fort Macon jetties, Beaufort, N. C., about low-water line, April, 1908.

This species closely approaches several others of the genus, but as none of these similar species has been found at Beaufort, this fact need not give trouble there. Of the Beaufort species, it most nearly resembles *C. crystallina*, from which it is distinguished by its flexuous, alternate branches. It has been observed at Beaufort only in April, 1908, not being found there in May, 1907, and not being present in Mullet Pond in August, 1907.

2. **Cladophora crystallina** (Roth) Kuetzing. Pl. LXXXIV, fig. 1.

Conferva crystallina, Roth, 1797, p. 196.
Cladophora crystallina, Kuetzing, 1845a, p. 213.
Cladophora crystallina, De Toni, 1889, p. 318.
Cladophora crystallina, Collins, 1909, p. 342.
P. B.-A. Nos. 1581, 1865.

Fronds yellowish or whitish green, soft, glossy, 10 to 30 cm. high; filaments slightly matted, distantly dichotomously or trichotomously branched; main branches 80 to 140 mic. in diameter, tapering to 25 to 40 mic. in the ramuli; branching erect or patent; upper ramuli sometimes whorled or alternately secund; cells cylindrical, 4 to 12 diameters long.

Massachusetts; West Indies; Bermuda; Europe.

Abundant on sea buoy, Beaufort, N. C., July, 1907.

A variable species, but usually marked by its light color and silky gloss. It is distinguished from *C. flexuosa*, the Beaufort species which it most nearly resembles, by its dichotomous or trichotomous branching and its straight branches.

3. **Cladophora fascicularis** (Mertens) Kuetzing.

Conferva fascicularis, Mertens, in Agardh, 1824, p. 114.
Cladophora fascicularis, Kuetzing, 1843, p. 268.
Cladophora fascicularis, De Toni, 1889, p. 316.
Cladophora fascicularis, Collins, 1909, p. 345.
P. B.-A. Nos. 122, 1228, 1472.

Fronds elongate, up to 50 cm. long; main filaments and principal branches flexuous, sparingly alternately branched, the ends beset with rather long, pectinate, more or less densely fasciculate ramuli; main filaments 200 to 250 mic. in diameter, cells 2 to 4 diameters long; ramuli 80 to 120 mic. diameter, cells usually 1 to 2 diameters long.

Florida; West Indies; South America; Red Sea.

Abundant in bay at New Inlet, Southport, N. C., August, 1909, floating and attached to shells and grass, 7 cm. above to 7 cm. below low water.

This is the most northern station reported for this species.

4. Cladophora prolifera (Roth) Kuetzing.

Conferva prolifera, Roth, 1797, pl. 3, f. 2.
Cladophora prolifera, Kuetzing, 1845a, p. 207.
Cladophora prolifera, De Toni, 1889, p. 306.
Cladophora prolifera, Collins, 1909, p. 348.

Fronds dense, dark green when growing, blackish when dried, up to 20 cm. high, rarely more; filaments coarsely membranaceous or cartilaginous, 300 to 400 mic. in diameter, dichotomous or trichotomous, divisions mostly erect, more frequent toward the somewhat fastigiate tips; ramuli 130 to 200 mic. diameter, blunt; cells up to 20 diameters long in the main filaments, much shorter in the branches, 4 to 6 diameters long in the ramuli.

Porto Rico; Barbados; Mediterranean; Red Sea.

Bogue Beach, Beaufort, N. C., two fragments, August and September, 1904, four small fragments, August, 1907(?).

A coarse, dark species, distinguished with comparative ease.

Besides the above-mentioned species, material of Cladophora, insufficient for specific determination, has been found at Fort Macon, on the buoys, on Bogue Beach, floating in Beaufort Harbor, and at Ocracoke. A few specimens gathered on Bogue Beach, August, 1907, resemble *C. catenata* (Ag.) Ardis., but are not included among the descriptions, since they are insufficient for a satisfactory determination. A small amount of Cladophora was collected in the harbor in January, 1909, but at no other time during the winter. Except for such scanty material, which is fairly constant on the sand breaks and rocks at Fort Macon during the summer and autumn, all the species of Cladophora at Beaufort seem to be transient visitors. None has been found there in any two successive years.

Family 2. GOMONTIACEÆ Bornet and Flahault.

Fronds consisting of creeping, branched filaments, penetrating various shells, in one species penetrating wood; cells multinucleate; asexual propagation by biciliate zoospores or possibly by aplanospores, both produced in sporangia formed usually on the upper surface of the horizontal layer; sexual reproduction by biciliate gametes (?).

Genus **Gomontia** Bornet and Flahault.

Gomontia, Bornet and Flahault, 1888a, p. 164.

Filaments usually radiating, irregularly branched; aplanospores develop directly into vegetative filaments, or first form new aplanosporangia (?).

Six species, mostly marine, two in fresh water, North America and Europe.

The observations of Moore (1918) tend to alter the previous conception of this genus, indicating that the structures previously regarded as aplanospores are formed from zoospores which pass into a resting condition and delay their germination for an indefinite time. No evidence for the existence of gametes was obtained by this author.

Gomontia polyrhiza (Lagerheim) Bornet and Flahault. Fig. 4.

Codiolum polyrhizum, Lagerheim, 1885, p. 22, pl. 28.
Gomontia polyrhiza, Bornet and Flahault, 1888a, p. 163.
Gomontia polyrhiza, Bornet and Flahault, 1889, p. CLII, pls. 6–8.
Gomontia polyrhiza, De Toni, 1889, p. 389.
Gomontia polyrhiza, Collins, 1909, p. 370, pl. 15, f. 135.
P. B.-A. No. 315.

Filaments 4 to 8 mic. in diameter; sporangia 30 to 40 mic. in diameter; zoospores of two sorts, one 10 to 12 by 5 to 6 mic., the other about 5 by 3.5 mic.; development not known; the smaller ones possibly gametes(?); aplanospores 4 mic. in diameter.

Abundant on both coasts of North America; Europe.

In shells, Pamlico Sound, Ocracoke, N. C., August, 1907.

Order 3. Siphonales.

Fronds filiform, usually much branched or interwoven into various forms, usually continuous without dissepiments in the vegetative condition, multinucleate, with many lens or disk shaped chromatophores.

The members of this order are, with few exceptions, marine and are mostly confined to tropical and warm temperate regions.

KEY TO FAMILIES.

a. Frond differentiated into root, stem, and branches of varied form.....4. CAULERPACEÆ (p. 434).
aa. Frond not differentiated into root, stem, and branches.....*b*.
b. Filaments interwoven to form fronds of definite form.....3. CODIACEÆ (p. 431).
bb. Filaments branching plumosely, not interwoven.....2. BRYOPSIDACEÆ (p. 431).
bbb. Filaments branching dichotomously or irregularly, forming indefinite mats .....1. DERBESIACEÆ (p. 430).

Family 1. DERBESIACEÆ Thuret.

Vegetative frond mostly unicellular, irregularly or dichotomously branched, forming indefinite mats, or consisting of upright branches arising from creeping filaments attached to the substratum by short, irregular branches; chromatophores large or small disks, each containing 1 to 3 pyrenoids, or lacking these; asexual propagation by means of almost spherical zoospores, formed (8 to 20) in sporangia arising as lateral branches of definite shape and cut off from the main filaments by cross walls, each zoospore possessing a circle of cilia and germinating immediately; sexual reproduction unknown.

About nine species, all marine, in North America, Europe, and Asia.

Genus **Derbesia** Solier.

Derbesia, Solier, 1847, p. 157.

Characters of the family.

About nine species.

Derbesia turbinata Howe and Hoyt. Pl. CXV, figs. 10–16.

Derbesia turbinata, Howe and Hoyt, 1916, p. 106, pl. 11, figs. 10–16.
Derbesia turbinata, Collins, 1918, p. 92.

Frond more or less creeping, forming straggling mats 8 to 9 cm. broad (or high?) the basal parts sometimes here and there resolved into cysts; filaments 16 to 100 mic. (mostly 40 to 55 mic.) in diameter, sparingly branched, the branching subdichotomous or more often lateral, the lateral branches usually without a basal septum, the others with or without one or two septa above the dichotomy; chloroplasts at first orbicular elliptic or ovate, 5 to 7 mic. in diameter, later irregularly confluent and spindle shaped; zoosporangia turbinate, broadly obconi-obovoid, broadly pyriform, or pestle shaped, 137 to

192 mic. long (excluding stalk), 124 to 164 mic. broad, mostly about as broad as long, the apex subtruncate, the outline commonly somewhat obdeltoid; pedicel mostly 15 to 33 mic. (rarely 75 mic.) long, 16 to 22 mic. broad, the pedicel cell usually about 19 to 22 mic. long and broad or sometimes broader than long (11 by 22 mic.); zoospores unknown; color dark green or olive green.

Several small mats mixed with Cladophora sp. dredged from coral reef offshore, Beaufort, N. C., August 11, 1914.

Endemic.

Family 2. BRYOPSIDACEÆ (Bory) De Toni.

Vegetative frond unicellular, much branched; chromatophores numerous small disks, each with one pyrenoid; the axis producing below rhizoids, and above branches both of unlimited and limited growth; in the latter large biciliate, green, female gametes, and usually(?) on separate individuals, smaller, brown, biciliate male gametes are developed; by the union of the two a zygote is formed, germinating immediately.

About 30 species, all marine, especially in warmer seas.

Genus Bryopsis Lamouroux.

Bryopsis, Lamouroux, 1809a, p. 133.

Characters of the family; cavity continuous, without dissepiments, in the vegetative condition.

Twenty to 30 species.

Bryopsis plumosa (Hudson) Agardh. Pl. LXXXIV, fig. 4.

Ulva plumosa, Hudson, 1762, p. 571.
Bryopsis plumosa, Agardh, 1822, p. 448.
Bryopsis plumosa, Harvey, 1858, p. 31, pl. 45, A.
Bryopsis plumosa, Farlow, 1882, p. 59, pl. 4, f. 1.
Bryopsis plumosa, De Toni, 1889, p. 431.
Bryopsis plumosa, Collins, 1909, p. 403, pl. 17, f. 155.
P. B.-A. No. 227.

Frond seldom over 10 cm. high, rich, glossy green; amount of branching variable; typical forms with numerous lateral branches and often a second series; all branches with abundant distichous ramuli, shorter above, giving the branches triangular outlines.

Maine to Florida; Europe.

Two or three large masses in harbor, Beaufort, N. C., growing under a wharf, 7 to 10 cm. below low water, April, 1908.

The most widely distributed species of the genus; it is nowhere very abundant, but occurs in various stations. In its northern range it seems to be more specially a summer plant, but is sometimes found at any season. Variable in appearance.

At Beaufort this species has not been found in summer, autumn, or winter, and was not observed in May, 1907.

Family 3. CODIACEÆ Zanardini.

Spongodiaceæ, De Toni, 1889, p. 488.
Udoteaceæ, De Toni, 1889, p. 499.

Frond of definite shape, except in the lowest forms, composed of interwoven, continuous, branching filaments, sometimes apparently pluricellular by constrictions, calcified or not; asexual propagation by zoospores and aplanospores, formed in sporangia; sexual reproduction by motile gametes, either similar or differing in size.

About 80 species, all marine, in tropical and subtropical regions, especially in warm seas.

KEY TO GENERA.

Not calcified nor stipitate, soft and spongy; cortical layer formed of the swollen ends of the longitudinal filaments; filiform or somewhat flattened.....1. Codium (p. 432).
Calcified and stipitate; cortical layer formed of lateral branches, usually smaller than the longitudinal filaments; lamina fan shaped.....2. Udotea (p. 433).

Genus 1. Codium Stackhouse.

Codium, Stackhouse, 1797, p. XVI.

Frond of spongy texture, of very varying form, consisting of branching, continuous filaments, their swollen ends—"utricles"—closely packed to form a cortical layer; no asexual propagation known; sexual reproduction by motile biciliate gametes, produced in subovoid gametangia, borne laterally on the utricles and separated from these by cross walls; female gametes large, dark green; male gametes small, yellowish; the zygote, formed by the union of a male and a female gamete, germinates immediately; female gametes sometimes germinate parthenogenetically(?); male and female gametes usually produced on different individuals, but sometimes on the same individual.

About 30 species described, many on insufficient characters; in tropical and temperate seas, mostly in warmer regions. This is the most northern station reported for the genus in North America, and is probably its northern limit.

The elongated forms of this genus are very variable. The characters on which many species have been described—the length of frond, amount of flattening, and comparative length and breadth of utricles—vary greatly and are often connected by intermediate stages.

At Beaufort the plants can be grouped around two types and are accordingly described as two species, although it is by no means certain that these should be kept distinct.

KEY TO SPECIES.

Frond more or less cylindrical except in the axils of the branches, abundantly branched ..... 1. *C. tomentosum* (p. 432).
Frond more or less flattened, sparingly branched ..... 2. *C. decorticatum* (p. 433.)

1. **Codium tomentosum** (Hudson) Stackhouse. Pl. LXXXV, fig. 1.

Fucus tomentosus, Hudson, 1732, p. 584.
Codium tomentosum, Stackhouse, 1797, p. XXIV.
Codium tomentosum, Harvey, 1858, p. 29 (in part).
Codium tomentosum, De Toni, 1889, p. 491.
Codium tomentosum, Collins, 1909, p. 388.
P. B.-A. Nos. 168, 1869.

Frond erect, cylindrical, dichotomously branched, more or less fastigiate; surface smooth and soft; utricles obovate-clavate, 100 to 150 mic., rarely 200 mic. in diameter(?), 3 to 6 diameters long, apex obtuse, unarmed.

North Carolina to Florida; West Indies; Europe; Asia; Africa; Oceanica.

Beaufort, N. C.: Very abundant, attached to rocks, shells, etc., throughout harbor and on Fort Macon jetties; less abundant on Shackleford jetties; very abundant on Bogue Beach after hard winds. Wrightsville Beach, N. C.: Abundant in sound, July, 1909. Pawleys Island, near Georgetown, S. C.: Fairly abundant in bay near inlet, August, 1909.

This is the northern limit of this species reported for North America. It is common at Beaufort from June to September, becoming less abundant during the autumn, and found only occasionally during the winter and spring. The only trace of these plants observed in April, 1908, was a group of minute specimens, 3 to 12 mm. long, on shells 15 cm. below low water, apparently just commencing their growth. In May, 1907, no specimens were found in the harbor, but three pieces, 2 to 3 cm. long, were dredged on the coral reef offshore, and a few small fragments were collected on Bogue Beach. Small specimens were collected in Beaufort Harbor and on Fort Macon jetties in January and February, 1909, but none was found at any other time during the winter. This may grow to a considerable size. The plant figured on Plate LXXXV, figure 1, found on Bogue Beach in October, had a radius of 30 cm. and, after the surface water was removed with a towel, weighed 1.942 kg. (4 pounds 4.5 ounces).

The species is distinguished from *C. decorticatum* by its more rounded, more densely branched thallus, and sometimes by its smaller utricles. The extremes of these species are very different in appearance, but they are connected by numerous intermediate forms so that it is often very difficult to decide to which species a given specimen should be referred, especially since the utricles may vary greatly in size, and the thallus is always more or less flattened below the dichotomies.

2. **Codium decorticatum** (Woodward) M. A. Howe. Pl. LXXXV, fig. 2.

Ulva decorticata, Woodward, 1797, p. 55.
Codium elongatum, Agardh, 1822, p. 454.
Codium elongatum, De Toni, 1889, p. 496.
Codium elongatum, Collins, 1909, p. 388.
Codium decorticatum, Howe, 1911, p. 494.
Codium decorticatum, Collins, 1912, p. 99.
P. B.-A. Nos. 627 (*C. elongatum*), 2017.

Frond dichotomously branched, often much elongate, younger divisions terete, older ones flattened, especially below the dichotomies, being there distinctly cuneate; utricles obovate-clavate, 300 to 400 mic. in diameter(?), five to six times as long as the greatest diameter.

North Carolina to Florida; West Indies; Lower California, Mexico; South America; Europe; Africa.

Beaufort, N. C.: Abundant on Bogue Beach after winds; occasional in Beaufort Harbor in earlier years, becoming more abundant in later years; abundant on rocks of Fort Macon jetties, July, 1909; and very abundant in harbor off Duncan breakwater and north of laboratory, September, 1909. Pawleys Island, near Georgetown, S. C.: Abundant in bay near inlet, August, 1909.

This is the northern limit of the species reported for North America.

The species is distinguished from *C. tomentosum* by the greater flattening, the more elongate, less densely branched frond, and sometimes by the larger utricles. The younger plants resemble *C. tomentosum*, but the flattening is marked in older plants; in some cases all parts except the younger tips are quite broadly cuneate. As, however, all plants of both species are more or less flattened below the dichotomies, and numerous intermediate forms are found, it is often difficult to determine on this basis to which species a given specimen should be referred. One specimen found at Beaufort had three main divisions, two of which were flattened like *C. decorticatum*, while the third resembled *C. tomentosum*. Dried specimens are particularly unreliable in this respect, since in these the amount of flattening may be largely due to the amount of pressure to which the plants were subjected during drying.

The size of the utricles furnished no criterion for distinguishing the plants of this region. While those on the coarsest, widest specimens are wider, those on other individuals having the form of *C. decorticatum* are narrower than many of those on individuals having the typical form of *C. tomentosum*.

If the two extreme forms found at Beaufort grade into each other in other localities as much as they do at this place, it may be questioned whether the present species is not merely a large form of *C. tomentosum*. On the other hand, however, the fact that it was first found at Beaufort on Bogue Beach and only in later years made its appearance in the harbor, indicates that it is a distinct species and that it established itself in this region during the period of this study. It seems, too, to appear here later in the spring and to disappear earlier in the fall than *C. tomentosum*. On this basis the intermediate forms may possibly be ascribed to hybridization.

This species may grow to a large size. One specimen collected on a jetty at Fort Macon had a length of 1 meter and a width of 5 cm. below its widest dichotomy.

Genus 2. **Udotea** Lamouroux.

Udotea, Lamouroux, 1812, p. 186.

Frond arising from a mass of rhizoids, differentiated into stipe and flabellum; stipe erect, with distinct cortex, terminating in a fan-shaped, more or less distinctly zonate flabellum, consisting of continuous, branching filaments, with more or less numerous short branches attached to each other by short processes and sometimes developing laterally into a more or less definite cortex; calcification more or less complete; reproduction unknown.

About 12 species, in tropical and warm temperate seas; seven of the species occur in North America.

This is the northern limit of the genus on this continent.

Udotea cyathiformis Decaisne. Fig. 5; Pl. LXXXIV, figs. 2 and 3.

Udotea cyathiformis, Decaisne, 1842a, p. 106.
Udotea conglutinata, Harvey, 1858, pl. 40 C (probably).
Udotea cyathiformis, De Toni, 1889, p. 512.
Udotea cyathiformis, Collins, 1909, p. 395.

Fronds 3 to 17 cm. high, greenish or whitish, more or less calcified; stipe mostly subterete, sometimes slightly flattened above, 0.2 to 5 cm. long, 1 to 6 mm. wide, corticated; transition from stipe to flabellum abrupt, flabellum uncorticated, cyathiform, now and then 1 to 5 cleft nearly or quite to the base, or more often early divided to base on one side and becoming almost flat, but usually remaining more or less concavo-convex at extreme base, then obovate, semiorbicular, or variously shaped, 1 to 11 cm. long, 1 to 9 cm. wide, mostly entire, often irregularly laciniate, rather faintly or not at all zonate; filaments of flabellum 40 to 135 mic. (mostly 60 to 100 mic.) in diameter, in several or many layers, nearly straight, parallel and rigid, somewhat flexuous and interwoven, distinct, each filament surrounded by a calcareous sheath which is perforated by numerous pores; branches of the stipe cortex in compact cymose-fastigiate clusters, the ultimate divisions scarcely longer than broad, truncate, truncate-obtuse, or very commonly with expanded truncate-capitate apices.

Florida; West Indies.

Dredged on coral reef offshore, Beaufort, N. C., about 15 specimens, 1 to 3 cm. long, May, 1907; 2 specimens, 4.5 cm. long, August, 1914.

This is the only species of Udotea that has been found in this region, but others are liable to occur. Most of them may be distinguished from the present species with comparative ease by means of the description given above; but one, *U. conglutinata*, closely resembles the present form and is liable to be confused with it. These species are, according to Howe (1909), distinguished as follows: *U. cyathiformis* has a goblet-shaped frond (sometimes split and more or less flattened), with abrupt transition in structure from stipe to flabellum; the corticating filaments of the stipe are compactly cymose-fastigiate, the ultimate divisions being scarcely longer than broad, obtuse, and often expanded at the apices (fig. 5). *U. conglutinata* has a flattened frond, with gradual transition in structure from stipe to flabellum; the corticating filaments of the stipe are somewhat loosely and irregularly fastigiate, the ultimate divisions being finger shaped, rather acute at apices (fig. 6). In difficult specimens these characters of the stipe cortex are especially useful in determining the species. Howe (1909) has given excellent descriptions and figures of these two species.

Family 4. CAULERPACEÆ (Reichenbach) De Toni.

Frond tubular, multinucleate, unicellular, traversed by cross strands of cellulose; multiplication apparently only by fragmentation of the frond; no asexual propagation or sexual reproduction known.

Only one genus.

Genus **Caulerpa** Lamouroux.

Caulerpa, Lamouroux, 1809b, p. 141.

Frond composed of a creeping stolon (wanting in one species), giving out rhizoids below and branches above, the latter of various form, usually erect, but sometimes prostrate, simple or branched.

About 80 species, in tropical and subtropical seas.

Caulerpa prolifera (Forskaal) Lamouroux.

Fucus prolifer, Forskaal, 1775, p. 193.
Caulerpa prolifera, Lamouroux, 1809b, p. 142.
Caulerpa prolifera, Harvey, 1858, p. 16, pl. 38 B.
Caulerpa prolifera, De Toni, 1889, p. 450.
Caulerpa prolifera, Collins, 1909, p. 413, pl. 18, f. 160.
P. B.-A. Nos. 269, 1872.

Stolon usually stout, naked, erect branches flat, linear, obtuse, up to 30 cm. long and 3 cm. wide, rarely divided, margin entire, sometimes slightly undulate, similar branches often arising proliferously from any point on the original branches; color blackish or olive green.

Florida; West Indies; Yucatan; Atlantic coast of northern Africa; Mediterranean.

One fragment of an upright branch, Bogue Beach, Beaufort, N. C., April, 1908.

It seems improbable that the fragment found here grew in this region at this season of the year; it seems much more probable that it was brought here by the Gulf Stream from Florida or the West Indies.

This is the most northern point reported for the species or the genus.

Division III. PHÆOPHYCEÆ (Thuret) Kjellman.

Zoosporeæ, Farlow, 1882, p. 40 (in part).
Oosporeæ, Farlow, 1882, p. 98 (in part).
Fucoideæ, De Toni, 1895, p. 1.

BROWN ALGÆ.

Algæ olivaceous brown, containing in their cells endochrome composed of chlorophyll and a characteristic brown pigment, fucoxanthin; endochrome contained in definite chromatophores; thallus varying extremely in size and form; cells containing mostly only one nucleus. Multiplication asexual or sexual: asexual (propagation) by motile noncopulating biciliate zoospores, or by aplanospores, or by specialized or nonspecialized portions of the thallus; sexual (reproduction) by zygotes formed by the copulation of gametes; gametes similar (isogametes), or different in form, size, etc.—that is, male and female (heterogametes)—usually motile, in some families differentiated into large nonmotile eggs and small motile sperms; all motile cells, zoospores or gametes, have two laterally inserted cilia except among the Dictyotaceæ where the sperms are monociliate; zoospores, aplanospores, and gametes produced in special organs (sporangia or gametangia) which are borne on ordinary portions of the thallus or on more or less specialized portions; asexual and sexual organs occurring on different individuals or, less often, on the same individual; in some forms, sexual and asexual generations alternating with each other in the life cycle; male and female gametes, when present, produced on the same or on different individuals; almost exclusively marine, some endophytic, a very few in fresh water.

About 1,000 species throughout the world, but reaching their greatest development in cold seas.

KEY TO ORDERS.

Asexual propagation by biciliate zoospores, rarely by nonmotile aplanospores; sexual reproduction usually by motile similar or dissimilar gametes, in one family by nonmotile eggs and motile biciliate sperms; sporangia and gametangia occurring on superficial portions of the thallus or arising from the transformation of surface cells.....1. PHÆOSPOREÆ (p. 436).

Asexual propagation lacking; sexual reproduction by nonmotile eggs and biciliate motile sperms; gametangia arising in sunken conceptacles usually on more or less specialized portions of the thallus.....2. CYCLOSPOREÆ (p. 449).

Asexual propagation by nonmotile aplanospores; sexual reproduction by nonmotile eggs and motile monociliate sperms; sporangia and gametangia arising from the transformation of surface cells, occurring singly or in groups, usually on ordinary portions of the thallus.....3. DICTYOTALES (p. 453).

Order 1. **Phæosporeæ** Thuret.

Phæozoosporinæ, De Toni, 1895, p. 293.

Thallus multicellular (in a few forms one to few celled), varying greatly in size and form; asexual propagation by fragments of the thallus or special "brood buds" (propagula) or by laterally biciliate zoospores, or by nonmotile aplanospores; sexual reproduction by motile, laterally biciliate gametes, similar or differing in form and size, or by nonmotile eggs and laterally biciliate motile sperms; spores and gametes produced in organs (sporangia, gametangia) formed from ordinary vegetative cells or from special cells; sporangia and gametangia occurring on superficial portions of the thallus or arising from the transformation of surface cells.

KEY TO FAMILIES.

a. Sporangia and gametangia occupying the place of branches of the frond or formed by the transformation of segments or portions of these segments; longitudinal growth intercalary.....1. ECTOCARPACEÆ (p. 436).

aa. Sporangia and gametangia formed by the transformation or division of a superficial cell, less often arising from the evolution of single segments of a segmented portion of the frond; longitudinal growth by intercalary division equally distributed through the whole frond or persisting a longer time at the base; frond simple.....2. ENCŒLIACEÆ (p. 442).

aaa. Sporangia and gametangia occupying the place of assimilating filaments or formed by the partial transformation of assimilating filaments.....*b.*

b. Longitudinal growth basal or lasting longest at the base.....3. ELACHISTEACEÆ (p. 444).

bb. Longitudinal growth terminal or subterminal.....4. CHORDARIACEÆ (p. 445).

aaaa. Sporangia and gametangia lateral on special segmented filaments arising from the frond.....*c.*

c. Longitudinal growth subterminal.....5. STILOPHORACEÆ (p. 447).

cc. Longitudinal growth trichothallic; brushes of confervoid filaments at the ends of the short branches.....6. SPOROCHNACEÆ (p. 448).

Family 1. ECTOCARPACEÆ (Agardh) Hauck.

Frond consisting of a creeping filament, usually with more or less conspicuous upright filaments arising from this, or of a one or two layered disk; usually monosiphonous, occasionally divided once or twice here and there in a longitudinal direction; more or less branched or subsimple; growth in length by intercalary division; sporangia and gametangia occupying the place of branches of the frond, or formed by the transformation of articulations or segments of these articulations; organs of fructification consisting of "unilocular sporangia," formed by the growth of a cell without formation of cross walls, or of "plurilocular sporangia," formed by the growth and repeated division of one or more cells; these usually occurring on different individuals, sometimes apparently on the same individual; male and female gametes produced on the same or different individuals.

About 130 species described, many of them doubtful, in all seas, but most abundant in the North Atlantic, mostly epiphytic.

The method of reproduction is exceedingly various, even within a single genus. The family seems to show the beginning of differentiation into asexual and sexual cells. The products of the "unilocular sporangia" are asexual, either motile zoospores or nonmotile aplanospores. The products of the "plurilocular sporangia" are asexual or sexual, being all alike, giving either zoospores or isogametes, or of two sizes, giving either zoospores of two sizes or heterogametes, or of three sizes, giving zoospores of two sizes

and possibly small gametes(?). Occasionally gametes, either male or female, may germinate without fusion. In addition to these, aplanospores may be formed in the "plurilocular sporangia." Both "unilocular" and "plurilocular" sporangia are formed in special branches or in portions of ordinary branches.

KEY TO GENERA.

Basal portion of the frond a filament expanded on the surface of the substratum; sporangia formed from special branches.....1. Ectocarpus (p. 437).
Basal portion of the frond a filament penetrating within other algæ.....2. Streblonema (p. 440).
Frond consisting of horizontal, more or less crowded, filaments, forming irregular or somewhat disklike patches on the surface of the host.....3. Phæostroma (p. 442).

Genus 1. **Ectocarpus** Lyngbye.

Ectocarpus, Lyngbye, 1819, p. 130.

Thallus consisting of few or many simple or branched upright filaments arising from a horizontal filament; attached to substratum by the horizontal filament, often assisted by rhizoidlike processes from the bases of the upright filaments; longitudinal growth in the upright filaments intercalary, in the horizontal filaments apical; filaments usually monosiphonous, very rarely polysiphonous by longitudinal walls here and there; asexual propagation by laterally biciliate zoospores and nonmotile aplanospores produced in "unilocular sporangia;" sexual reproduction by laterally biciliate motile gametes, similar or differing in size, etc., produced in "plurilocular sporangia;" both organs of fructification occurring in the place of branches, always singly, usually on different individuals, sometimes apparently on the same individual; "unilocular sporangia" usually globose, ellipsoid, or short pyriform, sessile or shortly pedicillate, opening by an apical pore; "plurilocular sporangia" various in form, usually ovoid or silique form, or narrowly subuliform, sessile, or pedicillate, usually opening by an apical pore, sometimes tapering at the apex to a segmented hair.

Numerous species described, but many on insufficient characters, about 40 to 70 recognized; in all seas, especially the North Atlantic.

An extremely difficult genus which has not yet received sufficient study to establish order among the innumerable forms occurring in it. One not familiar with the genus can scarcely hope to determine the species. Fruiting specimens are always necessary. The fruits are microscopic.

KEY TO SPECIES.

a. Frond 2 to 5 cm. tall, rarely more; "plurilocular sporangia" clavate, broad, obtuse or truncated at the apex, sessile.....1. *E. duchassaingianus* (p. 437).
aa. Frond usually 5 to 30 cm. and more tall.....*b*.
b. "Plurilocular sporangia" conical-subulate, rarely short ovate, often tapering to a hair .....2. *E. siliculosus* (p. 438).
bb. "Plurilocular sporangia" short subulate or fusoid, not tapering to a hair .....3. *E. confervoides* (p. 439).
bbb. "Plurilocular sporangia" elliptical oblong, obtuse.....4. *E. mitchellæ* (p. 439).

1. **Ectocarpus duchassaingianus** Grunow. Fig. 7.

Ectocarpus duchassaingianus, Grunow, 1867, p. 45, pl. 4, f. 1.
Ectocarpus duchassaingianus, De Toni, 1895, p. 545.
P. B.-A. Nos. 985, 2077.

Frond 1.5 to 4 cm. tall, forming muddy, dirty-looking tufts; branches spreading, usually short; diameter of filaments 15 to 34 mic., lower cells 2 to 3 diameters long, median ones 1 to 1.5 diameters, apical ones 3 to 4 diameters; sporangia of both kinds occurring on the same individual; "unilocular sporangia" ovate, sessile; "plurilocular sporangia" elavate, broad, ootuse or truncated at the apex, sessile, divided into numerous cells zonately arranged.

West Indies; Guadeloupe.

Fairly abundant on marine grasses, Newport River, near Green Rock, Beaufort, N. C., August, 1906.

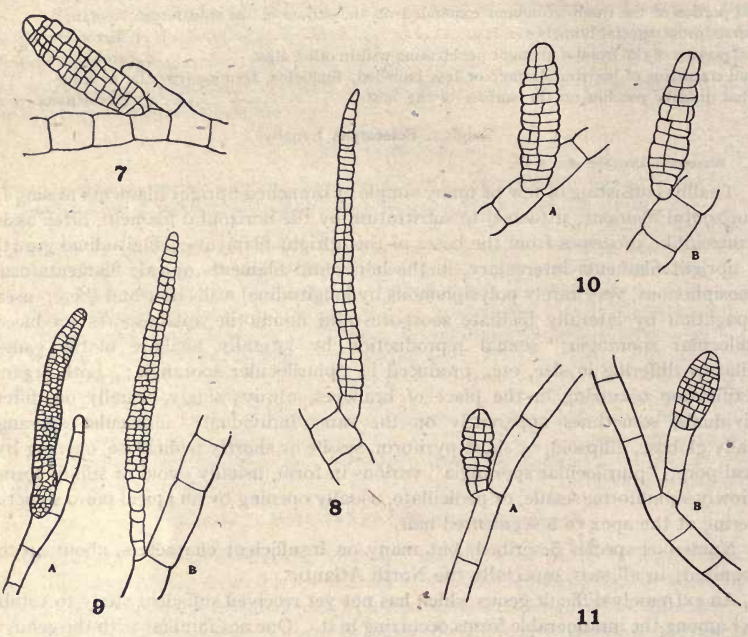


Fig. 7.—*Ectocarpus duchassaingianus*, "plurilocular sporangium," × 279.

Fig. 8.—*Ectocarpus siliculosus*, "plurilocular sporangium," × 279.

Fig. 9.—*Ectocarpus confervoides*, "plurilocular sporangia," × 279. A, Sessile; B, Shortly pedicellate.

Fig. 10.—*Ectocarpus mitchellæ*, "plurilocular sporangia," × 279.

Fig. 11.—*Ectocarpus* sp. from coral reef, 1914, "plurilocular sporangium," × 279.

This species can be distinguished from the others occurring at Beaufort by its small size, muddy appearance, tufted branches, and the shape of "plurilocular sporangia."

This is the northern limit reported for the species.

2. **Ectocarpus siliculosus** (Dillwyn) Lyngbye. Fig. 8.

Conferva siliculosa, Dillwyn, 1809, Supplement, p. 69, pl. E.
Ectocarpus siliculosus, Lyngbye, 1819, p. 131, pl. 43 C (excluding var. β and synonyms).
Ectocarpus viridis, Harvey, 1852, p. 140, pl. 12 B, C.
Ectocarpus confervoides var. *siliculosus*, Farlow, 1882, p. 71.
Ectocarpus siliculosus, De Toni, 1895, p. 549.
P. B.-A. Nos. 319, 1386, 2294.

Fronds 3 to 30 cm. long, yellowish or from brownish to olivaceous, forming flaccid tufts, attached or floating free; branching distinctly lateral or pseudodichotomous below; branches alternate or uni-

lateral, not opposite, often arcuately ascending; filaments 40 to 60 mic. in diameter; cells about 1 diameter long in the upper portion of the frond, often 4 to 5 diameters long below, somewhat constricted at the septa; sporangia of both kinds usually on the same individual; "unilocular sporangia" 30 to 65 (usually 50) mic. by 20 to 27 mic., ovoid or ellipsoid, sessile, or pedicillate; "plurilocular sporangia" 50 to 600 (usually 200) mic. by 12 to 25 mic., conical-subulate, rarely short ovate, sometimes slightly arcuate, often tapering to a hair; the products of the "plurilocular sporangia" are morphologically similar gametes; according to present views, the female gamete finally ceases its locomotion and usually fuses with an actively motile male gamete; the gametes of either sex may germinate without copulation.

Cold and temperate North Atlantic; Alaska; Mediterranean.

Beaufort, N. C.—Abundant throughout harbor, 5 to 15 cm. below low water, and on Bogue Beach, April, 1908; very abundant throughout harbor and on Fort Macon jetties, May, 1907.

This species is distinguished with difficulty from *E. confervoides*, with which it is often confused. It differs from the latter in the greater diameter of its branches and its usually more tapering "plurilocular sporangia." The sporangia of these two species seem, however, to intergrade. The illustration (fig. 8) shows about the average shape of the sporangia observed in *E. siliculosus* by the author. Some of these are very long and extended into a long, slender, pointed hair, while some are shorter, approaching closely to the more slender sporangia of *E. confervoides*.

3. **Ectocarpus confervoides** (Roth) Le Jolis. Fig. 9.

Ceramium confervoides, Roth, 1797, p. 151.
Ectocarpus confervoides, Le Jolis, 1863, p. 75.
Ectocarpus confervoides, Farlow, 1882, p. 71.
Ectocarpus confervoides, De Toni, 1895, p. 551.
P. B.-A. No. 871.

Fronds 2 to 50 cm. long, attached, deep brown; branches scattered, secund or alternate, not opposite; lower cells of the branches 18 to 40 mic. in diameter; "unilocular sporangia" oval or ellipsoidal, 23 to 30 mic. broad, 35 to 50 mic. long, sessile; "plurilocular sporangia" short subulate or fusoid, sessile or shortly pedicellate, 20 to 40 mic. broad, 60 to 400 mic. long, not tapering to a hair.

Cold and temperate North Atlantic and Pacific; Mediterranean.

Common in harbor and on rocks of Fort Macon jetties, Beaufort, N. C., January to April, 1909.

This species is distinguished with difficulty from *E. siliclulosus*, with which it is often confused. From this it differs in the smaller diameter of its branches and its less tapering "plurilocular sporangia." Authors have distinguished several varieties or forms, some perhaps agreeing in all respects with forms of *E. siliculosus*.

4. **Ectocarpus mitchellæ** Harvey. Fig. 10.

Ectocarpus mitchellæ, Harvey, 1852, p. 142, pl. 12 G.
Ectocarpus mitchellæ, Farlow, 1882, p. 72.
Ectocarpus mitchellæ, De Toni, 1895, p. 558.
P. B.-A. Nos. 321, 671, 1921.

Fronds 1.5 to 17 cm. long, yellow-greenish to dark brown, forming lax, feathery tufts; filaments slender, profusely branched; branches and branchlets alternate, ultimate ones approximate, all patent; cells of the branches 2 to 3 diameters long, those of the branchlets 1.5 diameters; "plurilocular sporangia" elliptical oblong or linear, very obtuse, sessile, divided into numerous cells, several together.

Warm and temperate North Atlantic and Pacific.

Abundant on other algæ, marine grasses, shells, etc., on shoals throughout harbor, on buoys, and on rocks of Fort Macon jetties, Beaufort, N. C., summer and autumn; Bogue Beach, March, 1909. Very abundant on marine grasses and rocks on shoals and jetties, Pamlico Sound, Ocracoke, N. C., August, 1907. Fruits throughout summer and autumn.

With the exception of *E. duchassaingianus*, collected in a single locality, this is the only determinable species of Ectocarpus that has been found at Beaufort in the summer and autumn.

A small amount of Ectocarpus evidently belonging to another species than those described here (fig. 11), but insufficient for specific determination, was dredged from the coral reef offshore from Beaufort in August, 1914.

Genus 2. **Streblonema** Derbes and Solier.

Streblonema, Derbes and Solier, in Castagne, 1851, p. 100.

Frond filamentous, monosiphonous, composed of decumbent primary filaments living within the tissue of other algæ, and erect secondary filaments arising from these; secondary filaments sometimes lacking, the upright portion consisting of only sporangia

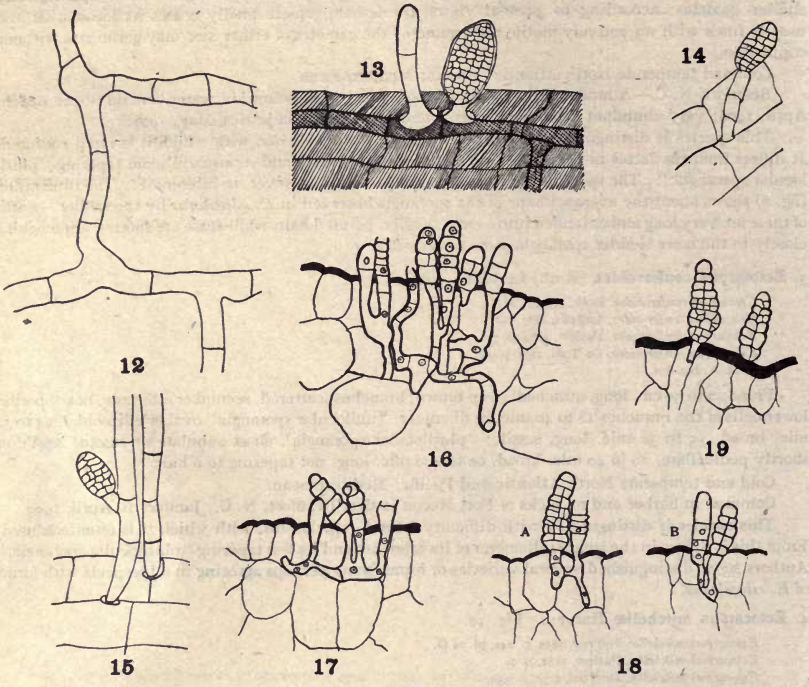


Fig. 12.—*Streblonema solitarium*, internal filaments branched and anastomosed, × 277.

Fig. 13.—*Streblonema solitarium*, internal filament bearing hair and "plurilocular sporangium," × 277.

Fig. 14.—*Streblonema solitarium*, terminal "plurilocular sporangium," × 277.

Fig. 15.—*Streblonema solitarium*, long external filaments and lateral "plurilocular sporangium," × 277.

Fig. 16.—*Streblonema invisibile* in *Meristotheca duchassaingii*, internal filaments bearing "plurilocular sporangia" of various ages and one hair, × 206.

Fig. 17.—*Streblonema invisibile* in *Meristotheca duchassaingii*, internal filament bearing "plurilocular sporangia" of various ages, × 206.

Fig. 18.—*Streblonema invisibile* in *Meristotheca duchassaingii*, internal filament bearing "plurilocular sporangium" and hair, × 206.

Fig. 19.—*Streblonema invisibile*, "plurilocular sporangia," × 206.

and hairs; branches of the decumbent filaments usually free, not anastomosing; sporangia usually occurring singly, subsessile on the decumbent filaments or terminal or lateral on short or long upright filaments; "unilocular sporangia" subglobose, rather large; "plurilocular sporangia" various in form, sometimes conspicuously branched, consisting of one or, for the greater part, many rows of cells in the longitudinal direction; products of "plurilocular sporangia" not known.

About 20 species, in other algæ, North Atlantic and Mediterranean.

KEY TO SPECIES.

Internal filaments 10 to 15 mic. wide, external filaments often long, plurilocular sporangia ovoid or ovoid-globose, 18 to 35 mic. wide.....1. *S. solitarium* (p. 441).
Internal filaments 5 to 8 mic. wide, external filaments short, plurilocular sporangia lanceolate, obtuse, 11 to 17 mic. wide.....2. *S. invisibile* (p. 441).

1. **Streblonema solitarium** (Sauvageau) De Toni. Figs. 12–15.

Ectocarpus solitarius, Sauvageau, 1892, p. 97, pl. 3, f. 24–27.
Streblonema solitarium, De Toni, 1895, p. 576.

Thallus mainly endophytic, filaments intercellular, 10 to 15 mic. wide, laterally and fairly profusely branched, occasionally anastomosing, giving off upright branches forming usually simple solitary hairs projecting about 0.1 to 1 mm. above the surface, cells 9 to 15 mic. wide, 2 to 4 diameters long; "plurilocular sporangia" terminal on short, upright filaments or lateral on the longer ones, ovoid or ovoid-globose, 25 to 105 by 14 to 45 mic.; "unilocular sporangia" unknown.

On *Dictyota dichotoma* on the Atlantic coast of France.

Fairly abundant on *Dictyota dichotoma* from the coral reef offshore from Beaufort, N. C., August, 1914.

The external filaments of this species are plainly evident under the microscope, and the internal filaments can be traced for long distances in the host. The upright branches reach the exterior through evident pores formed in the cell walls of the host. These pores are conspicuous on the surface of the Dictyota after the decay of the Streblonema filaments. At Beaufort the sporangia are usually borne on the ends of short filaments (fig. 14), but are sometimes lateral on long filaments (fig. 15), or borne on short stalks on the internal filaments (fig. 13); the internal filaments are branched fairly abundantly and seem to anastomose occasionally (figs. 12 and 13); the external filaments are usually simple, but sometimes branch. Although differing slightly from the published descriptions, there seems no doubt of the identity of this species.

This species is easily distinguished from the following by its larger size, its more luxuriant growth, the usually solitary paraphyses and sporangia, and the shape of the sporangia. It has not previously been recorded for North America.

2. **Streblonema invisibile** sp. nov. Figs. 16–19.

Thallus endophytic, filaments intercellular, usually 5 to 8 mic. wide, irregularly swollen here and there (in intercellular spaces?), variously and sparsely branched, traversing the host in all directions, giving off upright branches forming sporangia and short, simple hairs above the surface; "plurilocular sporangia" numerous, occurring in irregular patches, accompanied by a few hairs, lanceolate, obtuse, 25 to 55 by 11 to 17 mic., usually 40 to 45 by 14 to 17 mic.; "unilocular sporangia" unknown.

Thallo endophytico, filis intercellularibus, plerumque 5–8 mic. latis, hic illic inaequaliter tumidis (in spatiis intercellularibus?) varie et rare ramosis, passim hostem percurrentibus, ramos erectos sporangia et pilos breves et simplices externe formantes emittentibus; sporangiis plurilocularibus numerosis cum pilis paucis in locis inaequalibus, lanceolatis, obtusis, 25–55 x 11–17 mic., plerumque 40–45 x 14–17 mic.; sporangiis unilocularibus ignotis.

Abundant throughout the greater part of one tetrosporic specimen of *Meristotheca duchassaingii* J. Ag. collected on Bogue Beach, Beaufort, N. C., August 2, 1906.

A minute species, invisible to the naked eye, and even with the microscope scarcely visible except in section. Of the described species it seems to resemble most closely *Streblonema investiens* Thuret. From this it differs in having coarser, more irregular filaments with large, irregular swellings, confined below the surface of the host, the hairs projecting beyond the surface being very different from the projecting filaments of that species. Frequently a sporangium and a hair occur together as branches from a common filament.

This species is easily distinguished from the preceding by its smaller size, its less luxuriant growth, the occurrence of paraphyses and sporangia in clusters, and the shape of the sporangia.

The type and the slides from which the drawings were made have been deposited in the U. S. National Herbarium.

An undetermined species, apparently belonging to this genus, was abundant on several pieces of *Nitophyllum medium* collected on Bogue Beach in July and August, 1907, giving a brownish color to the host. The horizontal filaments branched irregularly, pursuing an irregular course among the cells of the Nitophyllum, from these short, vertical filaments, one to few celled, not visible to the naked eye, emerged to the surface. No fruit was observed, the specimens apparently being immature.

Genus 3. **Phæostroma** Kuckuck.

Phæostroma, Kuckuck, in Reinbold, 1893, p. 43.

Thallus composed of a small disk, usually monostromatic, consisting of radiating, branched, coalescent filaments, furnished with hairs arising by basal growth; both "unilocular" and "plurilocular" sporangia arising from the transformation of vegetative cells, rather prominent; "unilocular sporangia" globose or pear-shaped, opening by an apical cleft, "plurilocular sporangia" irregularly rounded or nodule-shaped.

Five species described, four of these from the northern shores of Europe. The genus has not previously been recorded from North America, except Greenland.

This genus, usually placed among the Encœliaceæ, has seemed to the author, from the vegetative structure and from the mode of formation of the reproductive organs, more nearly related to the Ectocarpaceæ, and has accordingly been placed there.

Phæostroma pusillum Howe and Hoyt. Pl. CXV, figs. 1–9.

Phæostroma pusillum, Howe and Hoyt, 1916, p. 109, pl. 11, figs. 1–9.

Thallus composed of horizontal branching filaments, forming irregular or somewhat disk-shaped patches, 0.3 to 0.8 mm. in diameter, closely attached to the surface of the host, usually consisting of a single, moderately compact layer with irregular margins; vegetative cells somewhat cylindrical or more often curved or of irregular diameter, mostly 10 to 16 mic. by 5 to 10 mic., usually 1.5 to 2 times as long as broad; hairs occasional, 8 to 10 mic. in diameter, showing at the base 4 to 6 short cells (5 to 10 mic. long); "unilocular" and "plurilocular sporangia" borne on separate individuals; "unilocular sporangia" either (1) scattered or aggregated, obovoid or somewhat globose, 8 to 16 mic. in diameter, sessile, or, (2) by subdivision and branching of the fundamental cell and by coalescence, forming elevated, submoriform sori 16 to 48 mic. in diameter, the ultimate sporangia then smaller, mostly 5 to 8 mic. in diameter, and often more angular; "plurilocular sporangia" scattered and solitary or forming loose clusters, ovoid, ellipsoid, or subconic, sessile, rather erect, 22 to 27 mic. by 15 to 18 mic.

Endemic.

Fairly abundant on *Dictyota dichotoma* and the creeping stolons of Campanularian hydroids on this, and occasionally on *Spyridia sp.*, from the coral reef offshore, Beaufort, N. C., August, 1914.

This species occurs on the Dictyota mixed with other filamentous species, but is easily distinguished from them by the descriptions and figures. It is not likely to be mistaken for any other species occurring in this region. It is not known elsewhere.

Family 2. ENCŒLIACEÆ (Kuetzing) Kjellman.

Frond extremely various in size and form, usually narrowed to a stipe below, attached by a rootlike disk or by rhizoids, usually simple, occasionally sparsely branched; structure parenchymatous; longitudinal growth intercalary, usually continuing longest in the lower part; both "unilocular" and "plurilocular" sporangia formed by the transformation of superficial cells or segments of these cells, external or immersed, occurring singly or grouped in sori, often accompanied by paraphyses; products of sporangia imperfectly known; in some cases isogametes, formed in "plurilocular sporangia," fuse to form a zygote; in other cases fusion of gametes apparently is not necessary for their development.

About 35 species, in all seas.

KEY TO GENERA.

Paraphyses lacking; sporangia, at least in the beginning, bound together into a tissuelike mass; frond band or leaf shaped..... 1. Petalonia (p. 443).

Paraphyses present or lacking; frond filiform, band shaped or intestine shaped. 2. Rosenvingea (p. 443).

Genus 1. **Petalonia** Derbes and Solier.

Petalonia, Derbes and Solier, 1850, p. 265.
Phyllitis, Farlow, 1882, p. 62.
Phyllitis, De Toni, 1895, p. 487.

Frond leaflike, without veins, usually band shaped, less often linear or filiform, tapering toward the base to a short, filiform stipe, occasionally fistulose; interior structure composed of larger cells intermixed with slender, segmented filaments, outer layer composed of smaller cells; sometimes hollow; paraphyses lacking; fertile regions at first as sori, then occupying nearly the entire surface of the frond; sporangia external, bound together, at least at first, into a tissuelike mass; "plurilocular sporangia" subcylindrical; "unilocular sporangia" insufficiently known.

Three species, in cold and temperate seas.

Petalonia fascia (Mueller) Küntze. Pl. LXXXVI, fig. 1.

Fucus fascia, Mueller, in Flora Danica, pl. 768.
Laminaria fascia, Harvey, 1852, p. 91.
Phyllitis fascia, Farlow, 1882, p. 62.
Phyllitis fascia, De Toni, 1895, p. 487.
Petalonia fascia, Küntze, 1898, p. 419.
A. A. B. Ex. No. 199 (*Phyllitis fascia*).
P. B.-A. Nos. 276, 736, 1131 (*Phyllitis fascia*), No. 1082 (*Petalonia zosterifolia*).

Frond extremely various in size and form, up to 30 cm. tall, 1 to 55 mm. broad, tapering cuneately below into a stipe springing from a shieldlike attachment, simple or branched.

Cold and temperate seas generally.

Abundant on rocks of Fort Macon and Shackleford jetties, less abundant in harbor, Beaufort, N. C., December to April, 1908 and 1909.

This species was not collected in November and seems to disappear entirely by May.

Genus 2. **Rosenvingea** Börgesen.

Rosenvingea, Börgesen, 1914, p. 178 (22).

Frond tubular, cylindrical, or slightly compressed, attached by a rootlike disk, branched, branches scattered or pseudodichotomous; growth intercalary by division of the cells of the entire frond; wall composed of 3 to 4 layers of cells, external ones small, becoming larger toward the cavity, peripheral cells containing single, disk-shaped chromatophores; hairs single or many aggregated, scattered over the entire frond, occurring either in the sori or on sterile portions of the frond; "plurilocular sporangia" subcylindrical or club-shaped, arising from the division of the cortical cells, occurring in sori forming very irregular spots scattered over the entire surface of the frond.

Four species in warm and temperate seas.

Rosenvingea orientalis (J. Agardh) Börgesen. Pl. LXXXVI, fig. 2.

Asperococcus orientalis, J. Agardh, 1848, p. 78.
Asperococcus orientalis, De Toni, 1895, p. 495.
Rosenvingea orientalis, Börgesen, 1914, p. 182 (26).
P. B.-A. No. 1640 (*Asperococcus orientalis*).

Frond tubular, light yellow-brown; 10 to 40 cm. long, 1 to 2 mm. diameter, dichotomous or vaguely branched, here and there constricted and twisted; branches usually tapering at base and apex, repeatedly dichotomous.

Warm waters of Atlantic, Pacific, and Indian Oceans.

Beaufort, N. C.: Abundant September and October, 1905, Bogue Beach; occasional in later years; fairly abundant attached to shells and marine grasses between jetties at Fort Macon, occasional on jetties, August and September, 1906 and 1907; occasional on sea buoy and Shackleford jetty, 1906 and 1907. Wrightsville Beach, N. C.; Fairly abundant in sound near inlet, August and September, 1909; abundant in almost pure masses on beach, August, 1909.

This species was first observed at Beaufort on the beach in 1905, it appeared in the harbor in 1906, was fairly abundant there for two summers, and then seemed to disappear, not being recorded for the region in 1908 or 1909.

It reaches its northern known limit at Beaufort.

Family 3. ELACHISTEACEÆ Kjellman.

Elachistaceæ, De Toni, 1895, p. 436.

Frond minute, sometimes almost microscopic, epiphytic, forming a pad or tuft consisting of a horizontal and an erect portion; horizontal portion consisting of loose or more or less closely adherent, branched filaments, upright portion consisting of filaments, usually branched below, simple above, loosely grouped, or more or less densely compacted, sometimes forming an almost parenchymatous structure below; filaments monosiphonous or polysiphonous, with longitudinal growth basal or lasting longest at the base; "unilocular" and "plurilocular" sporangia formed in the place of assimilating filaments, or by the transformation of single assimilating cells, or of offshoots from these cells.

About 20 species, in all seas, especially in the North Atlantic Ocean.

Genus Elachistea Duby.

Elachistea, Duby, 1832, p. 339 (19).
Elachista, De Toni, 1895, p. 439.

Frond forming small pads or tufts showing horizontal and erect portions; horizontal portion composed of monosiphonous branched filaments loosely or closely aggregated; from this arises the erect portion, usually consisting of a basal layer and erect filaments, the basal layer composed of branched, mostly colorless, monosiphonous filaments more or less densely compacted, sometimes forming an almost parenchymatous structure, erect filaments monosiphonous, simple or sparingly branched below, moderately or greatly elongated, richly colored; "unilocular sporangia" pear shaped, "plurilocular sporangia" filiform, usually consisting of a single row of cells, occasionally divided to form two rows of cells, both kinds of sporangia arising from the basal layer.

About 15 species, widely distributed, but most abundant in the North Atlantic Ocean.

Elachistea stellulata (Harvey) Griffiths. Figs. 20 and 21.

Conferva stellulata, Harvey, 1841, p. 132.
Elachista stellulata, Griffiths, in Areschoug, 1843, p. 261.
Elachista stellulata, De Toni, 1895, p. 439.

Thallus consisting of extensive endophytic filaments from which arise, here and there, external, hemispherical tufts of erect filaments and sporangia; internal filaments irregularly and profusely branched, frequently anastomosing, segmented, irregular in form and size, erect filaments and sporangia arising from a poorly developed basal layer, erect filaments 0.3 to 0.8 mm. long, 5 to 10 mic. wide, "unilocular sporangia" obovate or pear shaped, about 25 by 10 mic., "plurilocular sporangia" usually long, cylindrical, sometimes club shaped, obtuse, 30 to 50 by 5 to 10 mic.

On *Dictyota dichotoma*, England.

Fairly abundant on *Dictyota dichotoma* dredged from the coral reef offshore, Beaufort, N. C., August, 1914.

This species is visible as minute dots under a strong lens and is easily recognized under the microscope by the external hemispherical tufts of paraphyses and sporangia arising from widely scattered internal filaments. The internal filaments may be traced for long distances through the host. In European specimens the "unilocular sporangia" are the more abundant, but in the Beaufort plants these are very rare, and the "plurilocular sporangia" are abundant.

This species has not previously been recorded for North America.

Family 4. CHORDARIACEÆ (Agardh) Zanardini.

Frond convex-discoid or pulvinate, hemispherical or globose and finally hollow, or filiform and regularly branched, more or less slippery, sometimes almost gelatinous; segmented hairs always present; longitudinal growth terminal or subterminal; surface covered by short assimilating filaments; "plurilocular sporangia" formed either by the transformation of some segments of these filaments, or (like the "unilocular sporangia") in the place of filaments, or arising laterally on the filaments.

About 65 species, in all seas, especially in North Atlantic.

KEY TO GENERA.

a. Frond forming a horizontally expanded, parenchymatous, monostromatic disk with upright assimilating filaments ..... 1. Myrionema (p. 445).

aa. Frond forming a more or less large, upright body ..... *b*.

b. Longitudinal growth by transverse division of subterminal cells of the axial filament, assimilating filaments secondary; axial body of the frond composed of series of cells solidly joined together; filiform, branched ..... 2. Castagnea (p. 446).

bb. Longitudinal growth by transverse division of the upper segments of free apical filaments, the upper divisions finally changed into assimilating filaments; axial body of the fertile frond composed of rows of cellular filaments many times furcate, more or less loosely connected, anastomosing; hemispherical to subglobose ..... 3. Leathesia (p. 447).

Genus 1. Myrionema Greville.

Myrionema, Greville, 1827, vol. 5, pl. 300.

Thallus consisting of a very minute, horizontally expanded, round, or oblong disk composed of a single layer of rather closely packed cells, from which arise numerous erect, monosiphonous, assimilating filaments; sporangia arising from the basal disk on more or less elongated stalks; "unilocular sporangia" ellipsoidal or pear shaped, "plurilocular sporangia" silique shaped, at least in the lower part, consisting of several series of cells, usually borne on different plants, sometimes on the same plant.

Two to four species, on other plants, mostly in the North Atlantic Ocean and the Mediterranean Sea.

Myrionema strangulans Greville.

Myrionema strangulans, Greville, 1827, vol. 5, pl. 300.
Myrionema strangulans, Harvey, 1852, p. 132.
Myrionema vulgare, Farlow, 1882, p. 79.
Myrionema strangulans, De Toni, 1895, p. 399.
P. B.-A. Nos. 1795, 280 (*M. Leclancherii*), 32, 924, 1689 (*M. vulgare*).

Thallus forming minute spots more or less expanded over other plants, basal layer composed of elongated, segmented filaments almost joined into a membrane, with cells about 1.5 diameters long, vertical filaments numerous, densely crowded, club shaped, with short cells, intermixed with hyaline, confervoid filaments with elongated cells; "unilocular sporangia" obovoid, about 30 to 40 mic. long, 19 to 27 mic. wide, arising from the basal layer, borne on short stalks or almost sessile; "plurilocular sporangia" unknown.

North Atlantic and Mediterranean.

Fairly abundant on *Petalonia fascia*, from Fort Macon jetty, April, 1908 and 1909, and fairly abundant on *Nitophyllum medium*, Bogue Beach, summer and autumn, Beaufort, N. C.

This species was not found on Petalonia in December, 1908, nor January, 1909, was barely evident in February and March, and reached full development in April.

The specimens on Nitophyllum have not been observed in a mature condition, but seem to agree closely with this species.

This is the only species forming a disk on the surface of other plants which has been observed here. As, however, several members of the Ectocarpaceæ have this form and may be found in this region, determinations should not be based on this character alone.

Genus 2. **Castagnea** Derbes and Solier.

Castagnea, Derbes and Solier, 1856, p. 56.

Frond cylindrical, composed of an axis and peripheral radiating filaments with a stiffening, inconspicuous jelly; axis solid or tubular, composed of cylindrical, oblong cells joined into filaments tightly bound together by mucilage, forming almost a parenchymatous structure; the peripheral filaments of rotund cells, going out from the axis, approximate and fasciculate, the sterile branches rather simple, enfolding the sporangia, the fertile branches thrusting out externally shorter subsecund branches below their apices; "plurilocular sporangia" formed from the transformation of the upper (outer) segments of the assimilating filaments; "unilocular sporangia" produced as lateral offshoots from the base of assimilating filaments.

About six species, North Atlantic Ocean, Mediterranean.

The proper name for this genus is a matter of considerable doubt. But, as the author has had no opportunity for obtaining facts bearing on the question, it has seemed proper to follow the usage that is most current, even though further study should show that this name must be replaced by an earlier one.

Castagnea zosteræ (Mohr) Thuret. Pl. LXXXVII, fig. 1.

Rivularia zosteræ, Mohr, 1810, p. 367.
Castagnea zosteræ, Thuret, in Le Jolis, 1863, p. 85.
Castagnea zosteræ, Börgesen, 1914, p. 184 (28), f. 144–145.
(Not *Castagnea zosteræ*, Farlow, 1882, p. 86, pl. 7, f. 2.)
(Not A. A. B. Ex. No. 162.)
P. B.–A. Nos. 481, 1879 (*Castagnea mediterranea*).

Frond filiform, cylindrical, somewhat inflated, attached by a small basal disk, 7 to 20 cm. tall; branching sparse or fairly abundant, alternate and irregular, branches arising almost horizontally, short or elongated and ascending, sometimes irregularly divided at apices, tapering toward the base and apex; structure tubular, the central cavity being bordered by longitudinal filaments tightly bound together with mucilage, nearly all the cells of the outer filaments of this central tube giving off several short, lateral, assimilating filaments and an occasional hair, growth of the longitudinal filaments intercalary; "unilocular sporangia" oblong-ovate, arising from near the base of the assimilating filaments, "plurilocular sporangia" conical or irregular in shape, sometimes branched, arising from the apices of the assimilating filaments, "unilocular" and "plurilocular" sporangia occurring on the same plants; texture soft and rather gelatinous, the surface rough like the pile of velvet; color dark brown.

Atlantic coast of North America and Europe.

Fairly abundant on Bogue Beach, Beaufort, N. C., April 20, 1908; not found any other day.

The identity of this species has been, and still is, the source of much confusion. Harvey (1852) gives a species under the name *Mesogloia zosteræ* Aresch; Farlow (1882) uses the name *Castagnea zosteræ* (Mohr) Thur., giving as synonyms, among others, *Myriocladia zosteræ* Ag. and *Mesogloia zosteræ* Aresch.; De Toni (1895) does not give *Castagnea zosteræ*, but recognizes two species (1) *Myriocladia zosteræ* J. Ag., giving as a synonym, among others, *Mesogloia zosteræ* Aresch., Exs. No. 67, Tab. VIII, f. 1, *a* and *b*, and (2) *Eudesme virescens* (Carm.) J. Ag., giving as synonyms *Mesogloia zosteræ* Aresch., Alg. Scand. exs. No. 67, *Linckia zosteræ* Lyngb. and *Aegira zosteræ* Fries. Further study is needed to determine how many species are included here and to what genera these should be referred.

The species considered here seems to be the same as that discussed by Börgesen (1914), but it may, perhaps, be questioned whether it is the same as *Rivularia zosteræ* Mohr or *Castagnea zosteræ* Thuret. Both the Beaufort and the Bermuda plants are more branched than the more northern ones called by this name, and seem to belong to a different species.

The single occurrence of this species on the beach makes it probable that these plants did not grow in this locality, but were brought here from some other region. Since, however, it probably occurs both north and south of this place, it may be expected to establish itself here at any time.

Genus 3. **Leathesia** Gray.

Leathesia, Gray, 1821, p. 301.

Frond small, at first globose and solid, at length irregularly lobate and hollow, gelatinous-fleshy; axis short, composed of oblong cells joined into decompound-forked filaments radiating from a central point; peripheral assimilating filaments short, going out from the outermost smaller cells, enwrapped in mucous, simple, clavate, short, moniliform-segmented; longitudinal growth by transverse division of the upper segments of free apical filaments, the upper divisions finally changed into assimilating filaments; "unilocular sporangia" ellipsoid or pear shaped; "plurilocular sporangia" linear, composed of a single longitudinal series of cells; both kinds occurring at the base of peripheral filaments.

Five to six species, in cold and temperate seas.

Leathesia difformis (Linnæus) Areschoug. Pl. LXXXVIII, figs. 1 and 2.

Tremella difformis, Linnæus, 1755, p. 429.
Leathesia difformis, Areschoug, 1847, p. 376, pl. 9 B.
Leathesia tuberiformis, Harvey, 1852, p. 129.
Leathesia difformis, Farlow, 1882, p. 82, pl. 5, f. 1.
Leathesia difformis, De Toni, 1895, p. 422.
P. B.-A. Nos. 130, 829.

Frond subglobose, variously lobate, variable in size, about 1 to 5 cm. in diameter, olivaceous brown; at first solid, soon becoming hollow by the disintegration of the cells of the central axis; peripheral filaments clavate, the terminal cell enlarged; sporangia about 35 by 17 mic.

Cold and temperate North Atlantic and Pacific.

Abundant on other algæ and on rocks of Fort Macon jetties, Beaufort, N. C., April, 1908, March and April, 1909.

This is the most southern station reported for the species, although it may be found slightly farther south in the winter or spring. The species seems to make a short stay at Beaufort, not being found there in May, 1907, and being collected in only the two months noted during the winter and spring of 1908–9. The Beaufort specimens were small, having a diameter of 1 to 2 cm.

Family 5. STILOPHORACEÆ (Nægeli) De Toni and Levi.

Frond attached by a rootlike disk, filiform, more or less branched, composed of an axial bundle of segmented filaments increasing in length by the division of subterminal cells, and a parenchymatous, few-layered, cortical tissue clothing the axis; this cortical tissue arising from the lower cells of the segmented, subclaviform filaments springing from the axial bundle below its apex; frond solid when young, often becoming hollow with age, and traversed by branches of the axial filaments; assimilating filaments present; sporangia of both kinds formed as lateral branches from the base of short, simple, or branched filaments arising from superficial cells; "unilocular sporangia" obovate or club shaped; "plurilocular sporangia" linear, consisting of a single longitudinal row of cells.

Five to six species in North Atlantic and Mediterranean.

Genus **Stilophora** J. Agardh.

Stilophora, J. Agardh, 1836, p. 16.

Frond filiform, branched, firm, cartilaginous, finally hollow in the lower portions; growth in length apical; central axis composed of a few (usually four to five) series of cells; apex surrounded by tufts of filaments, arising laterally; peripheral assimilating filaments segmented, differing among themselves in form, either covering the surface of the frond or occurring in groups here and there; "plurilocular sporangia" uniformly distributed or grouped in more or less definite sori.

Four to five species in North Atlantic and Mediterranean.

Stilophora rhizodes (Ehrhart MS.) J. Agardh. Pl. LXXXVII, fig. 2.

Conferva rhizodes, Ehrhart MS., in Turner, 1819, vol. 4, p. 91.
Fucus rhizodes, Turner, 1819, vol. 4, p. 91.
Stilophora rhizodes, J. Agardh, 1841, p. 6.
Stilophora rhizodes, Harvey, 1852, p. 112, pl. 9 B.
Stilophora rhizodes, Farlow, 1882, p. 90, pl. 5, f. 4, pl. 6, f. 2
Stilophora rhizodes, De Toni, 1895, p. 390.
P. B.-A. No. 83.

Frond much branched, usually regularly dichotomous with more or less abundant minute lateral branches, 8 to 30 cm. long, about 1 mm. diameter below, yellowish when living, brownish when dry; branches elongated, plainly tapering toward the apices; sori separate, scattered among the more or less extensive sterile portions of the cortex, "unilocular" and "plurilocular" sporangia formed on different individuals.

Temperate North Atlantic; Mediterranean.

Beaufort, N. C.: Very abundant in Mullet Pond, on Shackleford Banks, May, 1907, April, 1908, loose or attached, lying in loose masses on the bottom; few specimens in tide pool in northwest corner of Town Marsh, May, 1907; one specimen in harbor north of laboratory, April, 1908.

Specimens from different localities vary greatly in more or less conspicuous tufts of peripheral filaments and in abundance of minute branches on various portions of the thallus. The Beaufort specimens have tufts of peripheral filaments large and conspicuous and few minute branches. In habit it is between the typical form and forma contorta Holden, occurring in masses with branches slightly contorted and intertwined. At Beaufort it occurred, with the exception of one specimen, in tide pools that were considerably warmer than the water in the harbor, but were very muddy. This is the most southern station reported for the species on our shores, but it may be found farther south in the winter or spring.

Family 6. SPOROCHNACEÆ (Reichenbach) Hauck.

Thallus usually filiform, sometimes narrow-band shaped, parenchymatous except at apices, where it is composed of tufts of free filaments; branching lateral, profuse, the branches in some cases differentiated into long and short ones; longitudinal growth trichothallic by a group of subterminal cells; only "unilocular sporangia" known, these are obovate, ellipsoid, or ellipsoid-cylindrical, produced as lateral outgrowths of special short, simple, or branched filaments arising from superficial cells; sporangiferous filaments occurring in sori scattered over the frond or confined to special regions.

About 20 species in warm and temperate seas, especially in the Australian region.

Genus **Sporochnus** Agardh.

Sporochnus, Agardh, 1820, p. 147.

Frond filiform, solid, regularly branched on all sides, usually having sharply distinct long and short branches, apices crowned with a tuft of free filaments; sporangia produced as lateral outgrowths uniformly distributed on short, more or less branched filaments with club-shaped branches and round pear-shaped end cells; sporangiferous

filaments occurring in sori surrounding the short branches immediately below the apices; fertile portions of these branches cylindrical, club shaped, ellipsoidal, or almost globose.

About 14 species, mostly in Australian region; 3 in Europe.

Sporochnus pedunculatus (Hudson) Agardh. Pl. LXXXVIII, fig. 3.

Fucus pedunculatus, Hudson, 1762, p. 587.
Sporochnus pedunculatus, Agardh, 1820, p. 149.
Sporochnus pedunculatus, De Toni, 1895, p. 380.

Frond filiform, arising from a very minute, discoid, rootlike callus, greenish to olive brown, up to 40 cm. tall; densely pinnate, long branches rather simple, alternate, 1 to 20 cm. long; short branches numerous on the long branches, occasional on the main axis, usually 1 to 2 mm. long or less, sometimes up to 5 mm. long, fertile portions at first subsessile and subglobose, then pedicillate and more or less elongated, obovate-ellipsoid; sporangia about 30 to 40 by 10 to 15 mic.

Atlantic from Scandinavia and England to northern Africa; Mediterranean.

Beaufort, N. C.: One specimen, Bogue Beach, August, 1907; few fragments dredged from the coral reef offshore, August, 1914.

The large specimen mentioned differs from most English specimens of the species in that it is coarser, has the short branches more scattered with longer peduncles, and the fertile portions of these branches ending more abruptly than in the English specimens, but the English specimens are themselves variable in these respects and some of them closely approach the Beaufort plant. This species has not previously been recorded from America, the specimens from Bermuda referred in the Challenger report to *S. pedunculatus* probably being another species. *S. bolleanus* Mont., which occurs in Bermuda, differs from the Beaufort specimen in being coarser and having longer peduncles, those of *S. bolleanus* being 2 to 6 times those of the Beaufort specimen, 0.5 to 1.5 times the length of the fertile portion of the branch.

The large specimen collected at Beaufort is 16.5 cm. long and seems complete, except that it lacks its attaching base, its long branches are 1 to 4 cm. long, it is in good condition, is fruiting abundantly, and when found seemed fresh and vigorous. It is probable that this grew on the coral reef offshore from Beaufort.

Order 2. **Cyclosporeæ** Areschoug.

Cyclosporinæ, De Toni, 1895, p. 3.

Frond often of striking size, various in form, branching, and structure, usually on rocks, less often epiphytic, with or without vesicles (floats, air bladders); usually bearing on the surface tufts of hairs arising from the interior of sunken, flask-shaped cavities (cryptostomata); no asexual propagation; sexual reproduction by nonmotile eggs and biciliate motile sperms; sexual organs (oogonia and antheridia) accompanied by paraphyses, formed within sunken, subspherical, hermaphroditic or unisexual conceptacles, communicating with the exterior by a narrow canal, usually on more or less specialized portions of the thallus; oogonia spherical or ellipsoidal, occurring singly on a short stalk, producing 1, 2, 4, or 8 relatively large, nonmotile eggs; antheridia numerous, occurring as branches on more or less branched filaments, producing numerous small, biciliate, motile sperms; eggs and sperms discharged through the neck of the conceptacle into the water where fertilization occurs.

Family FUCACEÆ De Toni.

Characters of the order.

About 300 species, mostly in salt water, some in brackish water, throughout the world, especially in Australian region.

KEY TO GENERA.

Frond flat, band shaped, dichotomously branched in one plane, furnished with a midrib ..... 1. Fucus (p. 450).

Frond distinctly differentiated into stem and leaflike portions, laterally branched, floats developed as special organs.....2. Sargassum (p. 451).

Genus 1. Fucus (Tournefort) Linnæus.

Fucus, Linnæus, 1737, p. 326 (in part).

Frond flat, band shaped, repeatedly dichotomously branched in one plane, furnished with a more or less conspicuous midrib, attached by a basal disk; vesicles present or absent, formed from swollen portions of the frond, often in pairs on each side of the midrib; cryptostomata more or less conspicuous here and there over the frond, bearing tufts of paraphyses; apical cell three-sided in young stages, soon becoming four-sided; receptacles formed from the more or less swollen apices; unisexual or hermaphroditic; oogonia producing eight eggs, accompanied by numerous paraphyses; antheridia ellipsoidal, numerous, occurring as lateral branches of richly branched filaments, producing numerous sperms, accompanied by paraphyses; eggs spherical, relatively large, nonmotile; sperms small, pear shaped, biciliate, actively motile.

About 16 species, in cold and temperate seas.

Fucus vesiculosus Linnæus. Pl. LXXXIX.

Fucus vesiculosus, Linnæus, 1753, p. 1158.
Fucus vesiculosus, Harvey, 1852, p. 71.
Fucus vesiculosus, Farlow, 1882, p. 100, pl. 9.
Fucus vesiculosus, De Toni, 1895, p. 206.
A. A.B. Ex. No. 109.
P. B.-A. No. 577.

Frond dark brown or black, coriaceous, band shaped, variable in form and size, 2.5 cm. to 1 m. long, 1 to 25 mm. wide; repeatedly and regularly dichotomous; tapering below to a distinct stipe; furnished with an evident midrib; cryptostomata more or less conspicuous; vesicles usually present, sometimes lacking, variable in form, size, and arrangement, usually occurring in pairs, one on each side of the midrib; receptacles forming swollen portions at the tips of the branches, more or less conspicuous, variable in size and form, somewhat flattened, turgid; antheridia and oogonia produced on different plants.

North Atlantic and Pacific Oceans.

Beaufort, N. C.: Abundant on innermost jetty, and occasional elsewhere at Fort Macon from low water up to 60 cm. above low-tide line, fairly abundant in harbor along shores, occasionally fairly abundant on Bogue Beach.

This is the southern known limit of the species and of the genus on our coast.

The species is variable in size and form, in the presence or absence of vesicles and the abundance and shape of these when they are present, in the conspicuousness of the cryptostomata, and in the size, shape, and conspicuousness of the receptacles. The vesicles may vary from numerous short, round ones, crowded together in places so that they resemble a double chain of beads, to few long, scattered ones, or they may be confluent, forming large, bladderlike structures, or may be lacking. The receptacles may be lacking (in sterile specimens), or may be small, or may form large, swollen portions at the apices, or may extend some distance from apices, they may be long and narrow or short and broad, their apices may be acute or obtuse. The Beaufort specimens are 4 to 5 mm. wide (at the vesicles up to 9 mm. wide) and 10 to 30 cm. long; the cryptostomata are inconspicuous, the receptacles are only slightly swollen and extend when young 3 to 6 mm., when mature 1 to 2.5 cm. from the apices, they are scarcely wider than sterile portions of the frond; their apices are acute. At Beaufort the plants are sterile during the spring and summer, commencing to form their receptacles in August and maturing these by November. Plants collected from November to January have mature fruits, those collected from April to August are entirely sterile. The species was not collected in February or March, 1909, but was probably present. In May, 1907, numerous small plants 2 to 3 cm. long were found, in addition to large ones up to 30 cm. long; all were sterile.

Genus 2. **Sargassum** Agardh.

Sargassum, Agardh, 1820, p. 1.

Frond attached by a basal disk or free floating, consisting of evident stem and leaf-like portions, bearing, in addition to these, vesicles and receptacles as separate organs; main axis short; branching lateral, alternate, decompound; stem terete, flattened, or angular; leaves variously shaped, sometimes branched, consisting of a flattened lamina usually on a short petiole, provided with a more or less conspicuous midrib traversing the entire leaf or extending through only the lower half, lamina sometimes reduced so that the leaf consists of little more than the midrib, margins smooth, serrate, or dentate; vesicles spherical, ellipsoidal, or obovate, sometimes flattened, occurring singly, formed from transformed leaves or parts of leaves (the transformation taking place at a young stage), borne on short stalks, often with flat, unaltered portions of the leaf remaining along the stalk and at the apex of the vesicle, the remnant at the apex often reduced to a spinelike tip; cryptostomata present only on the leaves, sometimes lacking; receptacles simple or branched, terete, flattened, or angular, often axillary; conceptacles usually spherical, communicating with the exterior by a narrow canal, hermaphroditic; oogonia accompanied by a few simple or branched paraphyses, producing only one egg; antheridia rotund on racemosely branched filaments.

About 160 species, grouped in five subgenera containing numerous sections, in warm and temperate seas throughout the world, especially in Australian region.

Some of the species are easily distinguishable, but most of them are separated by slight, inconspicuous characters. With the large number of species separated by slight differences, it is difficult to give an idea of these differences by descriptions. Determinations here, more than in most genera, can be made only by comparison with authentic specimens.

Seventeen species are reported for North America, 15 being found on the eastern coast. Most of these are southern, only one, *S. filipendula*, extending to the north, with one other, *S. natans*, often washed ashore. In the region studied, attached forms are apt to be *S. filipendula*, and floating ones are apt to be *S. filipendula* var. *montagnei* if fertile, or *S. natans* if sterile, although an occasional representative of other species may be found washed ashore.

While the extreme forms of these two species are easily distinguished, intermediate forms approach each other. Some specimens referred to *S. natans* by various workers bear a closer resemblance to *S. filipendula* var. *montagnei*. Such specimens will give much trouble to those who may try to name them.

Observations of Tahara and others show that in some species of this genus eggs are produced periodically at intervals of five to eleven days, apparently bearing no definite relation to the tides.

KEY TO SPECIES.

Cryptostomata usually lacking, leaf margins conspicuously serrate, branching rather irregular, usually sterile ..... 1. *S. natans* (p. 452).

Cryptostomata present, usually conspicuous, leaf margins often not conspicuously serrate, branching fairly regular, usually fruiting ..... 2. *S. filipendula* (p. 452).

1. **Sargassum natans** (Linnæus) Meyen. Pl. XC, fig. 1.

Fucus natans, Linnæus, 1753, Tom. 2, p. 1160.
Fucus bacciferus, Turner, 1802, vol. 1, p. 55.
Sargassum bacciferum, Agardh, 1820, p. 6.
Sargassum natans, Meyen, 1838, p. 185.
Sargassum bacciferum, Harvey, 1852, p. 59.
Sargassum bacciferum, Farlow, 1882, p. 103.
Sargassum bacciferum, De Toni, 1895, p. 82.
Sargassum natans, Börgesen, 1914a, p. 7.
A. A. B. Ex. No. 105 (in part).
P. B.-A. Nos. 382, 2180.

Fronds 15 to 45 cm. long, coriaceous, shining chestnut brown; stems terete, many times decompound; leaves lanceolate-linear, on a rather long petiole, occasionally forked, 4 to 10 cm. long, 1 to 7 mm. broad, acutely serrate, midrib distinct, cryptostomata usually lacking; vesicles spherical, on terete petioles whose length about equals that of the vesicles, usually provided with a spinelike tip; receptacles axillary, forked, cymose, cylindrical, verrucose; usually sterile.

Floating in North Atlantic, especially near the Gulf Stream. No specimen surely referable to this species is known attached.

Occasionally abundant in summer on Bogue Beach, Beaufort, N. C., not observed at other seasons. Fairly abundant on beaches at Southport, N. C., Georgetown, S. C., and Isle of Palms in the harbor of Charleston, S. C., July and August, 1909.

Forma **angustum** (Collins) comb. nov.

Sargassum bacciferum f. *angustum*, Collins, in Collins, Holden and Setchell, Phycotheca Boreali-Americana, No. 833, 1901.
A. A. B. Ex. No. 105 (in part).
P. B.-A. No. 833.

Leaves long, narrow, 2 to 6 cm. long, 1 mm. or less wide, in extreme cases consisting of little more than the midrib, conspicuously serrate, cryptostomata lacking; vesicles spherical, sometimes tapering very slightly at base, sometimes provided with a spinelike tip, petiole 1 to 3 times length of vesicle; sterile.

Floating in North Atlantic, with the species.

Occasionally abundant in summer, Bogue Beach, Beaufort, N. C., not observed at other seasons; probably in other localities also.

2. **Sargassum filipendula** Agardh. Pl. XC, fig. 2.

Sargassum filipendula, Agardh, 1824, p. 300.
Sargassum filipendula, Harvey, 1852, p. 61.
Sargassum vulgare, Farlow, 1882, p. 103.
Sargassum filipendula, De Toni, 1895, p. 106.
A. A. B. Ex. No. 101 (*S. vulgare*).
P. B.-A. Fasc. D. No. XCVII, Fasc. E. No. CXIX (*S. vulgare*).

Fronds 30 to 150 cm. long, yellowish-brown; stems terete or slightly flattened decompound, smooth; leaves linear-lanceolate or narrow linear, on a short petiole, sometimes forked, 1 to 5 cm. long, 1.5 to 12 mm. broad, larger and broader below, smaller and narrower above, acutely serrate or the upper narrower ones subentire, midrib distinct, cryptostomata more or less conspicuous, usually occurring singly, serially arranged on both sides of the midrib; vesicles spherical, on flattened petioles usually longer than the vesicles, usually provided with a spinelike tip; receptacles cylindrical, verrucose, paniculate on an elongated axillary branch, the lower ones pedicillate, rather simple, the upper ones confluent.

Warm and temperate North Atlantic.

Beaufort, N. C.: Abundant in harbor and on Fort Macon and Shackleford jetties throughout the year, from low-water line to 1 m. below low water; abundant on coral reef offshore at depth of 24 to 25.5 m., May, 1907, August, 1914, and August, 1915.

Most of the specimens from our coast which have been referred to *S. vulgare* Ag. belong to this species or to one of its forms, but specimens of the true *S. vulgare* are known from the extreme south, Key West, Fla., Mexico, and West Indies. The species differs from *S. vulgare* in having narrower leaves, longer petioles of vesicles, and more racemose branching of receptacles; many specimens have also less conspicuously serrate leaf margins, and the leaves less rigid and leathery. With its various forms the species shows much variation in the shape and size of leaves, the amount of serration, and the abundance of cryptostomata.

The Beaufort specimens fit the description of the species and resemble specimens from other localities referred to this species except that in the Beaufort plants the cryptostomata are inconspicuous and sometimes lacking. They have leaves broader and less serrate than in the type, these being as short and broad as in f. *contractum* J. Ag. with their margins almost as little serrate as in var. *montagnei* Collins and Hervey. In the Beaufort plants the leaves are lanceolate 1.5 to 3.5 cm. long, 3 to 7 mm. broad; the vesicles are rounded, tapering slightly at the base and sometimes very slightly at the apex, in the latter case bearing a short spinelike tip, their petioles are 1.5 to 3 times the length of the vesicle. The plants from the coral reef have large lanceolate leaves at the base, 8 to 8.5 cm. long, 1 to 1.3 cm. broad, long, narrow linear leaves at the apex, 3.5 to 5.5 cm. long, 3 to 5 mm. broad, approaching in appearance the leaves of var. *montagnei;* the serrations are inconspicuous on both kinds of leaves.

Var. **montagnei** (Bailey) Collins and Hervey.

Sargassum montagnei, Bailey, in Harvey, 1852, p. 58, pl. 1 A.
Sargassum vulgare var. *montagnei*, Farlow, 1882, p. 103.
Sargassum filipendula f. *subedentatum*, J. Agardh, 1889, p. 120.
Sargassum filipendula f. *subedentatum*, De Toni, 1895, p. 107.
Sargassum filipendula var. *montagnei*, Collins and Hervey, 1917, p. 83.
P. B.-A. No. 2176.

Leaves long, narrow, linear, 2 to 7.5 cm. long, 1 to 5 mm. wide, serrations almost or entirely lacking, the margins usually being smooth and wavy, cryptostomata often abundant and conspicuous; vesicles rounded or oblong on petioles 1 to 3 times the length of the vesicle; receptacles cylindrical, branched, cymose-racemose.

Atlantic shores of North America.

Abundant on Bogue Beach, Beaufort, N. C., summer and autumn; abundant in trawl offshore from Brown's Inlet, south of Beaufort, N. C., July, 1915.

The specimens belonging to this form often differ considerably from the species in appearance, but at Beaufort are fairly uniform among themselves. It is not known from what locality these plants have come.

Besides the species mentioned above, one sterile specimen of another species was found on Bogue Beach, Beaufort, N. C., August 20, 1908. This has rather thick, leathery leaves borne on short petioles, usually long, oblong, or elliptical, 1.5 to 2.7 cm. long and 5 to 9 mm. wide, a few being short elliptical, 8 to 13 mm. long and 6 to 10 mm. wide, cryptostomata are lacking, the margins are slightly serrate; the vesicles are obovate or rounded, of moderate size, and borne on short stalks. The specimen resembles in some respects herbarium specimens of *S. marginatum* (Ag.) J. Ag. or *S. ilicifolium* (Turn.) Ag., but can not be definitely referred to any species.

Order 3. **Dictyotales** Kjellman.

Tetrasporinæ, De Toni, 1895, p. 325.

Frond of medium size, attached to rocks, etc., light or dark brown, of various forms, usually membranaceous, flat, simple, lobate, or branched, nearly always erect, of parenchymatous structure; asexual propagation by relatively large nonmotile aplanospores, usually produced four (tetraspores), sometimes two or eight, from a mother cell (sporangium); sexual reproduction by relatively large, nonmotile eggs and small, motile, monociliate sperms; sporangia and gametangia on different plants, usually on unspecialized portions of the thallus, developed from superficial cells, occurring singly or in groups (sori), sometimes accompanied by paraphyses; oogonia and antheridia produced on the same or different plants; sexual and asexual generations, at least in some cases, alternating with each other; oogonia producing a single egg; antheridia producing numerous sperms; eggs and sperms discharged into the water where fertilization occurs.

Family DICTYOTACEÆ (Lamouroux) Zanardini.

Characters of the order.

About 120 species, all marine, mostly in warm seas, one species extending to Scandinavia.

KEY TO GENERA.

a. Frond growing by means of single initial cells situated at the apices.....5. Dictyota (p. 460).
aa. Frond growing by means of a group or groups of marginal cells situated at the apices.....*b*.
b. Frond zonate by concentric lines of growth, in the neighborhood of which the sporangia and gametangia are developed; fan shaped.....*c*.
c. Hairs lacking on the sterile portions of the frond.....1. Zonaria (p. 454).
cc. Hairs present on the sterile portions of the frond.....2. Padina (p. 455).
bb. Frond uniform, concentric lines of growth lacking; repeatedly dichotomous.....*d*.
d. Midrib lacking.....3. Spatoglossum (p. 458).
dd. Midrib present.....4. Dictyopteris (p. 459).

Genus 1. Zonaria Agardh.

Zonaria, Agardh, 1817, p. XX (in part).

Frond flat, fan shaped, often ascending from a prostrate lower part, growing by groups of cells along the apical margins, forming rather vague, scattered zones, divided into more or less narrow segments, often narrowed at the base of the frond and of the separate segments to a subcylindrical, stemlike portion densely covered by short, brown, rhizoidal filaments, this stemlike structure often continued as midribs for short distances on the flattened segments of the lamina; cortex composed of a single layer of cells arranged in pairs forming longitudinal lines radiating like a fan, each row of paired cells corresponding to a single row of interior cells; inner stratum consisting of several layers of cells; sporangia pear shaped, borne in more or less prominent sori, forming scattered, spotlike patches on one or both surfaces of the thallus, covered by the cuticle as an indusium which is burst as the sorus is elevated and soon disappears, sporangia often surrounded by numerous club-shaped, segmented paraphyses, bearing 8 spores; sexual reproduction unknown.

About 15 species in warm and tropical seas.

KEY TO SPECIES.

Frond entire or nearly so, stipe usually 3 to 5 mm. long.....1. *Z. variegata* (p. 454).
Frond much divided, stipe usually 1 to 5 cm. long.....2. *Z. flava* (p. 455).

1. **Zonaria variegata** (Lamouroux) Mertens. Pl. XCI, fig. 2.

Dictyota variegata, Lamouroux, 1813, pl. 5, f. 7.
Zonaria variegata, Mertens, in Martins, 1828, p. 6, pl. 2, f. 2.
Gymnosorus variegatus, De Toni, 1895, p. 227.
P. B.-A. Nos. 778 (*Gymnosorus variegatus*.), 2028.

Frond flat, fan shaped, rather erect on a short stipe, 3 to 9 cm. tall, 4.5 to 14 cm. wide, stipe 3 to 15 mm. (usually 3 to 5 mm.) long, thallus entire or more or less lobate, marked by variegated markings radiating from the base and by more or less conspicuous, distant, concentric zonations parallel with the apical margin; sori elliptical, forming broken lines or scattered spots between the zonations; texture thin membranaceous or parchmentlike; color olive brown to dark reddish brown.

Florida and West Indies to Brazil; Barbados; Bermuda; Canary Islands; Australian region; Red Sea; Hawaii; Philippines.

Bogue Beach, Beaufort, N. C., one specimen April, 1908, two specimens February, 1909, all sterile.

In this species the concentric zonations are sometimes fairly conspicuous, sometimes invisible to the naked eye. It is easily distinguished from the following species by its smaller size, shorter stipe,

radiating markings, and entire or almost entire laminæ, as well as by the absence of continuations of the stipe as "midribs" on the segments.

While the specimens found at Beaufort may have grown on the coral reef offshore, they may equally well have been brought there by the Gulf Stream from Florida or the West Indies. This is the northern known limit of the species and the genus.

2. **Zonaria flava** (Clemente) Agardh. Pl. XCI, fig. 1.

Fucus flavus, Clemente, 1807, p. 310.
Zonaria flava, Agardh, 1817, p. XX.
Zonaria flava, Harvey, 1858, p. 123.
Zonaria flava, De Toni, 1895, p. 230.
A. A. B. Ex. No. 91 (*Zonaria tournefortii*).
P. B.-A. Nos. 86, 1391 (*Zonaria tournefortii*).

Frond rather erect, 3.5 to 17 cm. tall, stipitate, attached by a cushion at the base, parchmentlike, substance almost horny, color reddish brown; stipe subcylindrical, elongated, branched, densely covered by short, brown, rhizoidal filaments; branches going off into a cuneate, flattened lamina, flabellately incised, marked by vague lines radiating from the base and by distant, more or less vague, concentric zonations parallel with the apical margins; stipe continued as midribs for short distances on the flattened segments of the lamina; lamina without midribs for some distance from the apical margins; sori forming irregular, spotlike patches scattered over the surface of the lamina.

California; Brazil; Canaries; Azores; North Africa; Spain; Mediterranean.

Beaufort, N. C.: Very abundant after hard winds, Bogue Beach, throughout the year; very abundant off northwest corner of coral reef at depth of 25.5 m., May, 1907, not found on reef. Fruits throughout the year.

Previously known with certainty from North America only from California, but specimens from Florida in the herbarium of the New York Botanical Garden marked *Z. lobata* Ag. (which species is now referred to *Stypopodium lobatum* (Ag.) Kuetz.) seem to be Zonaria and may belong to this species. This is the northern known limit of the species and of the genus.

The Beaufort specimens resemble the photograph of the type (from Italy) and specimens from California, but many Beaufort plants are larger than any specimens in Herbarium New York Botanical Garden. The California specimens available to the author were 3.5 to 7 cm. tall, small, and narrow, while the Beaufort plants are 7 to 17 cm. tall, large, broad, and much branched.

Genus 2. **Padina** Adanson.

Padina, Adanson, 1763, Tome 2, p. 13.

Frond flat, rather erect from a creeping, laterally branched rhizome, growing by groups of cells along the apical margins, forming conspicuous zones marked by concentric bands of short hairs, margin inrolled ventrally, subentire and kidney shaped or fan shaped, or repeatedly divided into spatulate to fan-shaped segments; narrowed at the base to a short, thickened stipe often covered with short, brown rhizoids; lamina sometimes composed of only two layers of cells, usually composed of three or more cell layers differentiated into one-layered, cortical strata and a one or more layered inner stratum; spores produced four in a sporangium; sporangia grouped in sori forming conspicuous scattered patches or more or less regular bands between the zones of hairs, usually covered by a more or less persistent indusium, occurring on one or both sides of the thallus; oogonia and antheridia grouped in sori, occurring on the same or different individuals; in the former case oogonia occurring in concentric bands broken by radial lines of antheridia, in the latter case both oogonia and antheridia occurring in concentric bands between the zones of hairs; oogonia and antheridia produced on one or both sides of the thallus.

About 10 species, in warm and tropical seas.

While this genus is easily recognized, distinctions between the species have been the source of much confusion in the past and are still made with great difficulty in some

cases. The characters which are most useful for separating the species and have been used by recent authors are the mutual arrangement of the sori and the lines of hairs, the presence or absence of an indusium covering the sori, and the number of cell layers in the thallus.

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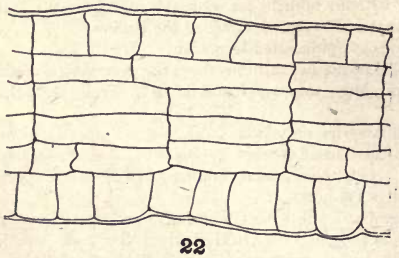

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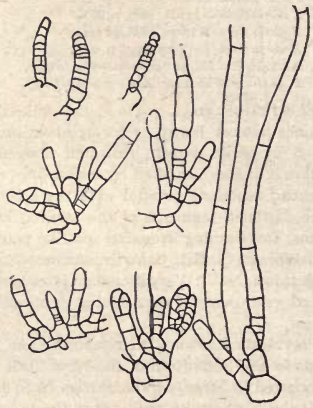

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Fig. 20.—*Elachistea stellulata*, internal filaments branched and anastomosed, × 273.

Fig. 21.—*Elachistea stellulata*, external filaments and "plurilocular sporangia," arising from basal disk as seen in optical section, × 273.

Fig. 22.—*Padina vickersiæ*, cross section of thallus, × 273.

Fig. 23.—*Goniotrichum alsidii*, × 300.

Fig. 24.—*Erythrotrichia carnea*, cells forming spores, × 300.

Padina vickersiæ Hoyt. Fig. 22; Pl. XCII, figs. 1 and 2; Pl. CXIV, figs. 1–3.

Zonaria variegata, Kuetzing, 1859, Bd. 9, p. 30, pl. 73, fig. 2.
Padina variegata, Vickers, 1905, No. 66.
Padina variegata, Vickers, 1908, pl. 8.
Padina vickersiæ, Hoyt, in Britton and Millspaugh, 1920, p. 595.

Thallus erect, flat, expanded, 4 to 22 cm. tall, 5 to 37 cm. broad, entire when young, when mature repeatedly more or less deeply laciniate from the margins into segments, varying from cuneate spatulate to fan shaped, sometimes incrusted with lime, zonate by piliferous lines parallel with the margins, often becoming inconspicuous in the older parts, interpilar zones 1.5 to 6 mm. wide, base consisting of a thickened, rounded stipe 3 to 12 mm. long, densely covered with brown rhizoids, attached by a basal disk; lamina consisting of 3-cell layers near revolute apical margins, of 4-cell layers throughout most of thallus, and of 6 to 8 cell layers toward the base, epidermal cells about half as long as the central cells; tetrasporangia covered by a thin, subpersistent indusium, borne on both surfaces, usually predominantly on the lower surface, occurring in 1 to 2 lines parallel with the apical margin about the middle of each interpilar zone, these lines frequently being broken, the tetrasporangia being scattered

throughout the zones on the older portions of the thallus; antheridia and oogonia borne on separate plants (dicœcious), occurring in sori in concentric bands, as with the tetrasporangia, borne on both surfaces, usually predominantly on the lower surface, oogonia covered by a thin, subpersistent indusium, antheridia naked (not covered by indusium); texture membranaceous; color light brown, sometimes olivaceous.

Thallo erecto, plano, expanso, 4–22 cm. longo, 5–37 cm. lato, juvenescente integro, maturascente interum atque interum plus minus alte ex marginibus laciniato, segmenta cuneato-spatulata aut flabellata formante, aliquando calce incrustato, zonato ab lineis piliferis cum marginibus parallelis, in regionibus vetustioribus saepe obscurescentibus, zonis interpilis 1.5–6 mm. latis, basi stipe densa rotundata 3–12 mm. longa, rhizoideis fulvis dense tecta, disco basali apta; lamina prope revolutas apicales margines ex tribus stratis cellularum, per maiorem partem thalli ex quattuor stratis cellularum, ad basim ex sex aut octo stratis cellularum constante, cellulæ epidermis circiter dimidio breviores quam cellulae centrales; tetrasporangiis ab indusio tenue et subpersistente tectis, in utraque superficie, plerumque pro maiore parte in inferiore superficie, in lineis unis aut duobus cum margine apicale parallelis circiter in unaquaque media zona interpilula productis, his lineis hinc inde fractis, tetrasporangiis in partibus adultioribus thalli per zonas sparsis; antheridiis et oogoniis ab plantis diversis in lineis concentricis sororum similiter tetrasporangiis, in utraque superficie, plerumque pro maiore parte in inferiore superficie productis; oogoniis ab indusio tenue et subpersistente tectis, antheridiis nudis (et non ab indusio tectis); substantia membranacea; colore dilute fulva, aliquande olivacea.

North Carolina to Florida; West Indies; Barbados; and Bermuda.

Beaufort, N. C.: Very abundant on Fort Macon jetties, 0 to 75 cm. below low tide; extremely abundant on Shackleford jetties and breakwaters, 0 to 1.2 m.; fairly abundant in harbor, June to October; one battered specimen on Fort Macon jetty, December, 1908.

The species here described has often been wrongly referred to *P. pavonia* J. Ag. or to *P. durvillæi* Bory. From the former it is distinguished by the arrangement of the sori, which are in one or two rows about the middle of each interpilar zone, instead of in single lines on both sides of each alternate piliferous line, as in *P. pavonia*. From *P. durvillæi* it is distinguished by the epidermal cells, which are usually about half as long as the central cells, whereas in *P. durvillæi* they are, in all specimens observed by the author, about one-fourth as long as the central cells. Occasionally those of *P. vickersiæ* are as long as the central cells, the two surfaces of the same section sometimes varying in this respect (fig. 22 and Pl. CXIV, figs. 1–3), while those of *P. durvillæi* are said to be half as long as the central cells. In any case, however, the epidermal cells of the present species are about twice as long, compared with the central cells, as those of *P. durvillæi*. In surface view the epidermal cells of *P. vickersiæ* are rectangular, having a length of two or more times their width, while those of *P. durvillæi* are usually about square. The latter species is also coarser and thicker than *P. vickersiæ*, sections showing six cell layers throughout most of the lamina and ten cell layers near the base.

The present species was first figured by Kuetzing (1859, Bd. 9, p. 30, pl. 73, f. 2) under the name *Zonaria variegata*, with the reference "Ag. spec. I. p. 127." This, however, refers to the true *Zonaria variegata* Mertens, whereas the plant figured by Kuetzing is a Padina. Miss Vickers (1905, No. 66) names this species *P. variegata* with the reference "*Zonaria variegata* Kuetz." Even if the rules of nomenclature allowed the recognition of a *Zonaria variegata* of Mertens and another of Kuetzing, the name *P. variegata* is rendered invalid by the fact that neither Kuetzing nor Miss Vickers published a description of the species. The citation of Börgesen (1914, p. 205 [49]) to *P. variegata* (Lamouroux) Hauck seems even less warranted. According to Howe (1915, pp. 49–50), *Dictyota variegata* Lamouroux seems, from both the published figures and the extant specimens of Lamouroux, to have been exclusively *Zonaria variegata*. Hauck's use of the name *Padina variegata* is merely an incidental mention and is founded only on a reference to Kuetzing. For both of these reasons this use of the name does not seem to constitute valid publication. In view of these facts, it has seemed necessary to give a new name to the species.

Our species, however, approaches very near to *P. dubia* Hauck (1887, p. 45) and may be identical with this. In Herb. Hauck there are four good unmounted specimens of *P. dubia* with a loose label written by Hauck. In habit, size, and number of cell layers they resemble the present species; the sori are often irregularly scattered over almost the entire surface but in parts are in regular zones just above each piliferous line.[a] The available material has not been sufficient to determine whether the

[a] The author is gratefully indebted to Dr. Marshall A. Howe for permission to quote from his notes on *P. dubia* as found in Herb. Hauck, as well as for the opportunity to study portions of two of the original specimens of this species.

distribution of the sori is the same as that of *P. vickersiæ*, but it is certainly closely similar ("*P. variegata*" and *P. dubia* being placed in the same group by Hauck on the basis of this character), and in other respects the two species seem identical. It seems, therefore, very probable that these belong to a single species. But, in view of some uncertainty regarding similarity in the arrangement of the sori and in view of the opinion expressed by Hauck that his material of *P. dubia* did not entirely agree with the "*Zonaria variegata*" of Kuetzing, it has seemed better to keep the species separate until *P. dubia* can be more thoroughly studied. If the two are found to belong to a single species, both *P. variegata* (Kuetz.) Vickers and the present name must be reduced to synonyms.

The type of the species here described is a tetrasporic plant from Fort Macon jetty, Beaufort, N. C., August 23, 1907. This and several cotypes have been deposited in the U. S. National Herbarium.

The tetrasporangia, oogonia, and antheridia are borne on separate plants (the species being dicœcious), and the sexual and asexual generations seem, from the results of Wolfe (1913, 1918), to alternate with each other as in Dictyota. There is evidence (Wolfe, 1918), for believing that the eggs may be fertilized before being discharged from the oogonium. Unfertilized eggs may commence their development parthenogenetically as in Dictyota, but apparently never (Wolfe, 1914, 1918), under such conditions, reach maturity. According to observations of Howe,[a] the tetrasporangia also may commence development without undergoing division, forming many-celled brood buds or propagula. The further history of these bodies is unknown.

The portions of the cuticle covering the sori are raised by the developing tetrasporangia and oogonia as distinct indusia covering the fruiting areas (Pl. CXIV, figs. 1–3), while those covering the antheridia are not raised as distinct layers, and the antheridia accordingly appear naked. Although Börgesen (1914) figures an indusium covering the antheridial sorus, the author, after careful study of sections of well-preserved material, has been unable to find these in any case. In spite of this discrepancy, the plants of Börgesen and those referred to here almost certainly belong to the same species. The indusia, when present, are very delicate and are finally ruptured by the developing sori; they are, consequently, often absent from mature fruits and frequently are not evident on dried plants. The tetrasporic and female plants closely resemble each other but can easily be distinguished by the fact that the tetrasporangia have about twice the diameter of the oogonia, mature tetrasporangia measuring 41 to 90 by 47 to 108 mic. and the oogonia 27 to 45 by 36 to 63 mic. Frequently, moreover, all the oogonia on a single plant are of the same age, while the tetrasporangia, although usually of the same age in a single zone, are borne in successively younger zones toward the apical margins. There is some evidence that the sexual cells are borne in periodic crops at weekly intervals, but in other cases oogonia (or antheridia) of several different ages are borne on the same individual.[b]

Two other species of Padina are recorded from the West Indies. These, if found, may be distinguished from the present species by the following characters:

P. sanctæ crucis Börgesen.—Frond consisting of two cell layers, tetrasporangial sori in concentric zones above each alternate line of hairs.

P. gymnospora (Kuetzing) Vickers.—Frond consisting of three cell layers, tetrasporangial sori in concentric zones in middle of each alternate zone between the lines of hairs, sori not covered by indusia.

Genus 3. **Spatoglossum** Kuetzing.

Spatoglossum, Kuetzing, 1843, p. 339.
Spathoglossum, De Toni, 1895, p. 246.

Frond flat, ribbonlike, subpalmate-dichotomous, growing by groups of cells at the apices, surface uniform, zonations lacking; margin smooth or dentate; midrib lacking; cortex composed of a single layer of cells arranged in straight parallel lines; inner stratum composed of several layers of cells; spores produced four in a sporangium; sporangia scattered over both surfaces, occurring singly or several together in small groups; oogonia and antheridia produced on different plants; oogonia occurring singly, scattered over the surface; antheridia in small, scattered, inconspicuous sori.

About eight species, in warm and tropical seas.

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[a] The author is gratefully indebted to Dr. Marshall A. Howe for permission to refer to these unpublished results.

[b] The author is indebted to Prof. J. J. Wolfe for considerable information regarding the life habits of Padina at Beaufort.

Spatoglossum schrœderi (Mertens) J. Agardh. Pl. XCIII, fig. 1; Pl. XCIV, fig. 2 a and b.

Ulva schrœderi, Mertens, in Martins, 1828, pl. 2, f. 3.
Taonia schrœderi, Harvey, 1852, p. 107.
Spatoglossum schrœderi, J. Agardh, 1880a, p. 113 (in part).
Spathoglossum schrœderi, De Toni, 1895, p. 249.
A. A. B. Ex. No. 159 (*Taonia schrœderi*).
P. B.-A. Nos. 326, 2027.

Frond membranaceous, thin, dichotomous, or sometimes subpalmate with approximate segments and irregularly decompound above by new segments sprouting from the margins; these segments somewhat contracted at their bases; margin entire in younger portions, later distinctly distantly serrate; color yellowish brown.

Florida to Brazil; West Indies; Bermuda; Guadeloupe.

Beaufort, N. C.: Three plants in one small mass on Fort Macon jetty, August, 1906; few fragments dredged from coral reef offshore August, 1914 and 1915.

This species often closely resembles *Dictyota dichotoma*, from which it is easily distinguished by its groups of initial cells at the apices of the branches and by its serrate margins. All three of the plants from Beaufort Harbor were fruiting abundantly, bearing numerous tetrasporangia scattered thickly over both surfaces. The plants from the coral reef have decidedly dentate margins, while those found growing in the harbor have almost smooth margins with only a few ciliate projections.

This is the only species of this genus known from North America, *Spatoglossum areschougii* J. Ag. (which has been listed for this continent), now being regarded as belonging to the present species.

This is the northern known limit of the species and of the genus.

Genus 4. **Dictyopteris** Lamouroux.

Dictyopteris, Lamouroux, 1809a, p. 129.
Haliseris, De Toni, 1895, p. 253.

Frond erect, flat, more or less regularly dichotomous, growing by groups of cells at the apices, surface uniform, zonations lacking; provided with a conspicuous midrib and, in some species, with veins running from the midrib to the margins; lamina transient in the basal portion, the frond finally consisting in this region of the persistent midrib forming a stemlike structure; cortex composed of a single layer of cells; inner stratum composed of several layers of cells; spores produced four in a sporangium; sporangia occurring in sublinear or spotlike sori on both sides along the midrib on both surfaces of the frond; oogonia and antheridia produced on the same plant; oogonia occurring singly, scattered over both surfaces; antheridia in small inconspicuous, scattered, slightly sunken sori, especially in the region of the midrib.

About 14 species, in warm and tropical seas.

It is interesting that both the species found at Beaufort should be new to North America. *D. serrata* has an especially interesting distribution, being previously reported only from the eastern coast of Africa and from the present locality.

KEY TO SPECIES.

Margin smooth or undulate, often lacerate, not serrate; no nerves running from midrib.... ..... 1. *D. polypodioides* (p. 459).
Margin serrate; nerves running from midrib to margins..... 2. *D. serrata* (p. 460).

1. **Dictyopteris polypodioides** (Desfontaine) Lamouroux. Pl. XCIII, fig. 2.

Fucus polypodioides, Desfontaine, 1798, Tom. 2, p. 421.
Dictyopteris polypodioides, Lamouroux, 1809a, p. 131.
Haliseris polypodioides, De Toni, 1895, p. 254.

Frond 7.5 to 72 cm. long, 0.4 to 1.2 cm. wide, on a more or less elongated subterete stipe; color olive brown; repeatedly dichotomous, with occasional branches arising laterally and from the midrib on the flat surface of the frond; numerous groups of short hairs scattered over the lamina; sinuses rather

acute, segments patent, attenuated at the apices; margins entire or often lacerate, smooth, often undulate; no nerves running from midrib; tetrasporangia in small or large, inconspicuous, more or less confluent sori along both sides of the midrib; antheridial sori uniformly scattered over the frond.

Brazil; Europe; Tasmania; Red Sea; Arabian Gulf.

Beaufort, N. C.: Occasional on rocks of Fort Macon jetties, summer and autumn; occasional on Bogue Beach, spring, summer, and autumn; extremely abundant alongshore for distance of more than 22 km. from New River Inlet, south of Beaufort, and extending at least 12 km. offshore, at depth of 5.8 to 12 m., August, 1914; very abundant in trawl offshore from Browns Inlet, south of Beaufort, July, 1915.

This species has not previously been reported from North America. The specimens from this region closely resemble specimens from England and France. Those from New River Inlet are the largest which have been observed by the author.

2. **Dictyopteris serrata** (Areschoug) comb. nov. Pl. XCIII, fig. 3.

Haliseris serrata, Areschoug, 1847, p. 4, pl. 7.
Haliseris serrata, De Toni, 1895, p. 259.

Frond 8 to 30 cm. long, 1.4 to 3 cm. wide, on an elongated, slightly flattened stipe; color yellow brown; sparingly dichotomous; hairs occurring in scattered groups over the lamina; sinuses subrotund, segments patent, attenuated at the apices; margins usually entire, with acute, approximate, or more distant serrations; lamina furnished with more or less numerous, fairly conspicuous nerves running from the midrib obliquely toward the margins; sporangial sori small and inconspicuous, in more or less regular lines parallel to the veins in the intervenous spaces; oogonia produced on both surfaces, scattered over the frond, especially along midrib and margins.

Port Natal, Africa; Mauritius.

Fairly abundant July and August, 1903, Bogue Beach, Beaufort, N. C., occasional in spring, summer, and fall of other years; several large plants dredged from the coral reef offshore, August, 1914, and August, 1915.

This species has been previously reported only from Port Natal, Africa, but a specimen in the herbarium of the New York Botanical Garden was collected in Mauritius. The Beaufort specimens differ from the description in having slightly more rounded apices and slightly less rotund sinuses. They sometimes differ from the plate in Kuetzing (Tab. Phyc. IX, pl. 60) and from the specimen in the herbarium of the New York Botanical Garden in having less conspicuous veins and smaller, more numerous serrations. From the latter specimen they sometimes differ also in having a lighter color and a thinner texture, the inner stratum consisting of one to two layers of cells instead of uniformly two layers, as in that specimen. In spite of these differences there seems no doubt that the specimens from Beaufort are correctly referred to *D. serrata*. They certainly belong to Dictyopteris and, if not this species, must be described as a new one. The differences do not seem sufficient to warrant the description of a new species.

In the Beaufort plants the apices are sometimes sunken, as in fern prothalli. In one specimen the veins occasionally, instead of running out to the margins, form plexuses of small veins between the midrib and the margin and between the dichotomies of the midrib. Both tetrasporangia and oogonia have been observed on the Beaufort specimens.

Genus 5. Dictyota Lamouroux.

Dictyota, Lamouroux, 1809c, p. 331.
Dictyota, Lamouroux, 1809, p. 38.

Frond erect, flat, ribbonlike, sometimes rising from a rhizomelike, rounded portion, usually regularly dichotomous, growing by a single initial cell at the apex of each branch, surface uniform, zonations lacking; no midrib present; cortex composed of a single layer of small cells; inner stratum composed of a single layer of rather large cells; spores produced four in a sporangium; sporangia occurring singly or in small groups scattered over both surfaces of the frond; oogonia and antheridia produced on different plants,

in conspicuous roundish or ellipsoidal sori, scattered over both surfaces; oogonial sori black, antheridial sori whitish.

About 37 species in warm and temperate seas, one extending to Scandinavia.

Dictyota dichotoma (Hudson) Lamouroux. Pl. XCIV, figs. 1, 2 c and d, and 3.

Ulva dichotoma, Hudson, 1762, p. 476.
Dictyota dichotoma, Lamouroux, 1809, p. 42.
Dictyota dichotoma, Harvey, 1852, p. 109.
Dictyota dichotoma, De Toni, 1895, p. 263.
P. B-A. Nos. 282, 1641, 2175. Fasc. E. No. CXX.

Frond erect, flat, ribbonlike, sometimes narrowed at the base to a very short stipelike portion, attached by a small, padlike thickening; regularly dichotomous, sometimes with irregular branches given off from the apices and from the margins; margins smooth, entire; apices usually rounded, obtuse, sometimes rather acute; tetrasporangia, and oogonial and antheridial sori scattered all over both surfaces except base, tips, and margins; tetraspores produced continuously, not in regular crops; oogonia and antheridia produced in crops at regular intervals; sexual and asexual plants showing a regular alternation of generations.

Reported from warm and temperate waters generally, extending in Europe as far north as Norway and Helgoland.

Very abundant on Fort Macon and Shackleford jetties, Beaufort, N. C., and in harbor from low water to 1 m. below low water, and occasionally abundant on Bogue Beach, June to October; fairly abundant in Newport River near "Green Rock"; abundant in North River off Lennoxville and Marshallburg; one small mass floating in Core Sound off Davis Island; two plants 2 cm. long on coral reef off Beaufort, N. C., May, 1907, and fairly abundant, August, 1914 and 1915. Abundant in sound near Moores Inlet, Wrightsville Beach, N. C., July to September, 1909.

This is the northern known limit in North America of the species and of the genus.

The species varies considerably in size, width, amount of branching, and acuteness of apices, varying from plants 1 to 3 mm. wide and 6.5 cm. long to plants 4 to 16 mm. wide and 29 cm. long. The average of six well-developed plants from Beaufort was 4 to 12 mm. wide, 18 cm. long. The branching may be frequent, forming a short, dense habit, or may be infrequent, forming a long, open habit. The apices, while usually obtuse, may be acute. The Beaufort plants, while varying in these respects, show less variation than English specimens.

All the specimens of this species dredged from the coral reef, August, 1914, were very narrow and finely divided, with numerous almost linear proliferations (Plate XCIV, fig. 2 *c* and *d*).

Plants from unfavorable situations are narrow, often spirally twisted, and usually small. The apices of these plants are often acute. Some apices of larger plants may be acute at times, since, when conditions are changed to less favorable ones or sometimes after fruiting, there are formed narrow projections from the apices. These may widen out later or may grow out as proliferations from the apices, later widening out and branching dichotomously. Plants collected at the beginning of this process, if examined by themselves, would often be determined as *D. bartayresiana* Lamour. Under different conditions of growth plants may resemble *D. bartayresiana* Lamour., *D. divaricata* Lamour., *D. dichotoma* f. *latifolia* (Kuetz.) Vinassa, f. *attenuata* (Kuetz.) Vinassa, or f. *implexa* (Lamour.) Vinassa. These three last-named forms are at Beaufort only growth forms occurring under different conditions in the environment. *D. bartayresiana* can itself not be sharply distinguished from *D. dichotoma*, since specimens of these species may overlap. Many specimens of *D. dichotoma* from England are narrower and more acute at the apices than shown in photographs of the type of *D. bartayresiana*.

D. dichotoma, wherever carefully observed, has been found to produce its sexual cells in regular periodic crops. In the three European stations where this process has been studied—Bangor, Wales, and Plymouth, England (Williams, 1905), and Naples, Italy (Lewis, 1910)—the plants produce two crops a month at regular intervals related to the tidal seasons, the relations of the crops to the tides varying in the different localities. At Beaufort (Hoyt, 1907), only one crop a month is produced, this being initiated from three days before up to the day of the greatest springtide at the time of the full moon, as shown by the tide tables, and being liberated from three to six days after the day of the greatest springtide. The relation between the greatest springtide and the times of initiation and liberation of the

crop varies within the given limits in different summers but is fairly constant in any one summer. At Beaufort and Naples, and probably elsewhere, the sexual cells are liberated at or a little before dawn.

In spite of this great difference in the production of their crops, the close morphological similarity of the Beaufort plants to those of Europe seems to preclude the placing of these in a separate species. The facts mentioned above, however, show that the characters which have been used to separate certain species—the size and width of plants and the acuteness of the apices—are not by themselves safe characters for specific distinctions.

The studies of Williams (1904, 1904a) and the cultures of Hoyt (1910) have shown that in this species the sexual and asexual generations alternate with each other in regular succession.

Division IV. RHODOPHYCEÆ Ruprecht.

Rodospermeæ, Harvey, 1852, p. 1.
Florideæ, Farlow, 1882, p. 106.
Florideæ, De Toni, 1897, p. 1.

RED ALGÆ.

Algæ colored rose, crimson, or purple, less often violet, olivaceous, green, or blackish, containing in their cells endochrome composed of chlorophyll, and a characteristic red pigment (phycoerythrin) mixed with other pigments; endochrome contained in definite chromatophores; thallus varying greatly in size and form, composed of segmented, separate, or more or less coalescent filaments; cells containing one or more nuclei. Multiplication asexual or sexual. Asexual propagation usually by spores, sometimes by brood cells or brood buds; spores usually produced four (tetraspores), sometimes one (monospore), two, or many in a sporangium, at first naked, later inclosed by a membrane, usually nonmotile, in some cases possessed for a time of slight amœboid movement, but apparently always passively distributed; sporangia external or immersed, distributed over the thallus or borne on more or less specialized portions. Sexual reproduction by the fusion of dissimilar male and female gametes borne on the same or different individuals. Male gametes (spermatia) naked, nonmotile, produced one or many in a more or less specialized antheridium, discharged into the water and passively transported; antheridia usually external, sometimes immersed, borne on specialized or unspecialized portions of the thallus, in the Bangiales formed by the transformation and division of ordinary vegetative cells. Female gametes occurring singly within special organs, never escaping free into the water. These organs, usually immersed, sometimes external, are, in the Bangiales, formed by the direct transformation of swollen vegetative cells; in the Florideæ they are borne at the ends of short, usually three or four celled filaments (carpogenic branches) each organ (carpogonium) consisting of a swollen basal portion and a hairlike, apical prolongation, the trichogyne. Associated with these organs in reproduction there are, in most orders of the Florideæ, special cells, auxiliary cells, which are either joined with the carpogonium in a common structure, the procarp, or occur separately in the thallus more or less near the carpogonia. In the fusion of male and female gametes a spermatium is floated to the trichogyne and fuses with this, the male nucleus passing down and fusing with the female nucleus in the swollen basal portion of the carpogonium. This fertilized egg cell then either directly produces tufts of spore-bearing filaments (gonimoblasts), or, in most orders, gives off longer or shorter filaments bearing the fertilized egg nucleus or some of its descendants, these filaments fusing with the auxiliary cells, and the auxiliary cells then giving rise to spore-bearing filaments. The fruits thus produced (sporocarps) are often inclosed by a more or less specialized sterile jacket, the whole structure constituting the

cystocarp. The nonmotile spores (carpospores) borne in these fruits are discharged into the water and germinate immediately. Carpogonia and sporocarps are borne externally or immersed on specialized or unspecialized portions of the thallus. Sexual and asexual cells are nearly always produced on different individuals, the sexual and asexual plants, at least in some cases, alternating with each other in the life cycle; antheridia and carpogonia are borne on the same or different individuals. Almost exclusively marine, a few in fresh water, some endophytic.

About 3,000 species throughout the world but most abundant in warm seas.

KEY TO CLASSES.

Thallus filamentous or foliaceous, usually unbranched; asexual and sexual organs formed from ordinary vegetative cells.....1. BANGIOIDEÆ (p. 463).
Thallus variously formed, usually branched; asexual spores (usually four) produced in special sporangia; sexual gametes borne in antheridia and carpogonia.....2. FLORIDEÆ (p. 467).

Class 1. Bangioideæ De Toni.

This class contains only one order.

Order **Bangiales.** Schmitz and Hauptfleisch.

Thallus filiform, disk shaped or foliaceous; asexual propagation by spores produced from ordinary vegetative cells or by akinetes; sexual reproduction by apparently nonmotile spermatia and eggs produced from ordinary vegetative cells.

Family BANGIACEÆ (Zanardini) Berthold.

Thallus small or of medium size, attached to rocks, etc., colored various shades of red or purple, sometimes blue or greenish, sheets of one or two layers of cells, or of disks, or of filaments composed of one or more cell rows; cells having a single nucleus and a single star-shaped chromatophore; asexual propagation by spores produced one or more from ordinary vegetative cells, occasionally by akinetes; sexual reproduction by minute, apparently nonmotile spermatia, which are discharged into the water, and large eggs which are retained within the enveloping organ; numerous spermatia formed by division of ordinary vegetative cells which function as antheridia; eggs usually produced singly, formed from ordinary vegetative cells, which may in some cases be regarded as simple carpogonia, since they frequently form hairlike protuberances somewhat similar to the trichogynes of Florideæ, the spermatia then fuse with these protuberances; the fertilized egg divides into a few (usually eight) spores, or, rarely, may be transformed directly into a single spore; both the sexually produced and the asexual spores are naked when first discharged into the water, and frequently are possessed of slight amœboid movement, but are soon surrounded by walls and apparently are always passively transported. Asexual and sexual organs are, in different species, produced on the same or on different individuals, as is also the case with male and female organs.

About 45 species, nearly all marine, a few in fresh water, throughout the world, especially in temperate seas.

KEY TO GENERA.

a. Asexual spore formed from the contents of a vegetative cell without division, sexual reproduction apparently lacking ..... 3. Goniotrichum (p. 465).
aa. Asexual spore formed from the smaller of two cells arising from the unequal division of a vegetative cell by an oblique wall, sexual reproduction usually present ..... *b.*
b. Thallus consisting of erect filaments ..... 4. Erythrotrichia (p. 466).
bb. Thallus consisting of branched filaments creeping on or in the surface of other algæ, and more or less fusing to form a single-layered disk ..... 5. Erythrocladia (p. 466).
aaa. Asexual spores formed by approximately equal division of a vegetative cell (sometimes without division), sexual reproduction present ..... *c.*
c. Thallus filiform ..... 1. Bangia (p. 464).
cc. Thallus membranaceous, flat ..... 2. Porphyra (p. 464).

Genus 1. **Bangia** Lyngbye.

Bangia, Lyngbye, 1819, p. 82.

Thallus erect, filiform, unbranched, attached by an expanded base, more or less thickened above, terete, commonly irregularly constricted, sometimes tubular and hollow above. Asexual spores, formed from the entire contents of vegetative cells or from cells formed by one (or sometimes two) divisions of vegetative cells, are discharged into the water and germinate immediately. Numerous spermatia formed by repeated division of vegetative cells which function as antheridia. Eggs arising singly from the entire contents of enlarged vegetative cells. Fertilized eggs divide into a few (usually eight) spores, which are discharged into the water and apparently germinate immediately. Asexual and sexual organs borne on the same or on different individuals, male and female organs produced on the same or different individuals.

About 10 species described, but not sharply separated, mostly marine, occasionally in fresh water.

Bangia fusco-purpurea (Dillwyn) Lyngbye.

Conferva fusco-purpurea, Dillwyn, 1809, pl. 92.
Bangia fusco-purpurea, Lyngbye, 1819, p. 83, pl. 24 C.
Bangia fusco-purpurea, Farlow, 1882, p. 112.
Bangia atro-purpurea, var. *fusco-purpurea*, De Toni, 1897, p. 112.
P. B.-A. Nos. 87, 2084.

Thallus filamentous, erect, 0.5 to 15 cm. long, attached to rocks, etc., variable in color and size, pink to purple, younger filaments composed of one or two rows of cells, older filaments forming a hollow tube.

Cold and temperate North Atlantic and Pacific; Mediterranean.

Abundant between tide lines on rocks of Shackleford jetty, Beaufort, N. C., May, 1907, and fairly abundant on Shackleford and Fort Macon jetties, April, 1908; probably occurs from December to May.

Specimens vary greatly in appearance on account of their differences in size and color; the filaments vary from a fineness that is indistinguishable to the naked eye to the thickness of a coarse hair; the cells vary greatly in diameter.

This is the southern limit reported for the species, but specimens are known from points farther south, and the species will probably be found to extend along our entire coast during the winter.

Genus 2. **Porphyra** Agardh.

Porphyra, Agardh, 1824, p. XXXII.
Porphyra, De Toni, 1897, p. 13.
Wildemania, De Toni, 1897, p. 20.

Thallus erect, foliaceous, flat and thin, margin entire, lobate or laciniate, often undulate, attached by a basal disk, base substipitate; at first consisting of a simple

filament, soon developing into a flat membrane consisting of one or two cell layers; propagation and reproduction as in Bangia; spore fruit consisting of eight or more cells.

About 20 species, all marine, many of them not sharply separated.

Porphyra leucosticta Thuret.

Porphyra leucosticta, Thuret, in Le Jolis, 1863, p. 100.
Porphyra atropurpurea, De Toni, 1897, p. 17.
P. B.-A. No. 376.

Frond shortly stipitate, attached by a basal disk, consisting of a single layer of cells (except during reproduction), variable in color from pink or red to purple and in form from indefinite sheets to narrow bands, simple or variously divided, 2 to 40 cm. long, 0.5 to 14 cm. wide; monœcious, antheridia forming small, elongated, colorless patches among the darker female organs.

Temperate North Atlantic and Pacific; Mediterranean.

Very abundant between tide lines throughout harbor and on jetties, Beaufort, N. C., January to May.

At Beaufort the plants are kidney shaped to linear, lanceolate and laciniate, 3 to 10 cm. long, of a pinkish or brownish purple color.

Another species, *P. laciniata* (Lightf.) Ag. has not been observed in this region, but may be found here at times, although it is, in general, a more northern form than *P. leucosticta*. These species can not be separated by form or color, but are distinguished as follows: *P. leucosticta*, monœcious, antheridia occurring in small, elongated, colorless patches; *P. laciniata*, usually dicœcious, antheridia forming a colorless marginal zone.

Genus 3. **Goniotrichum** Kuetzing.

Goniotrichum, Kuetzing, 1843, p. 244 (in part).

Thallus erect, filamentous, consisting of a single row of cells, exhibiting "false branching," or, occasionally, laterally branched; cells rose colored, containing single, star-shaped chromatophores and single nuclei; cell walls soon becoming gelatinous; asexual propagation by transformation of vegetative cells into monosporangia, their contents soon escaping as naked monospores; sexual reproduction unknown.

Two species recognized.

The members of this genus are peculiar in combining characters of the blue-green and the red algæ. In their possession of "false branching" and gelatinous sheaths formed by the swelling of the cell walls inclosing the filaments, they resemble the Myxophyceæ, while the structure of their cells, and especially their method of propagation, place them among the Bangiaceæ in the Rhodophyceæ.

Goniotrichum alsidii (Zanardini) Howe. Fig. 23.

Bangia alsidii, Zanardini, 1839, p. 136.
Goniotrichum elegans, Zanardini, 1847, p. 254 (69).
Goniotrichum elegans, Forti, in De Toni, 1907, p. 687.
Goniotrichum elegans, Tilden, 1910, p. 295.
Goniotrichum alsidii, Howe, 1914a, p. 75.
P. B.-A. No. 781.

Filaments red, 1 to 5 mm. long, inclosed in gelatinous sheaths; cells cylindrical or elliptical, 7 to 10 mic. wide, 11 to 20 mic. long; sheaths 2 to 6 mic. wide on each side of filament, often with crenate edges.

Warm and temperate North Atlantic.

Occasional on other algæ and on eel grass (*Zostera marina*), usually occurring in very small quantities, abundant on one old specimen of *Padina vickersiæ*, Fort Macon jetty, December, 1908, and occasional on various algæ dredged from coral reef offshore, Beaufort, N. C., August, 1914 and 1915.

Genus 4. **Erythrotrichia** Areschoug.

Erythrotrichia, Areschoug, 1850, p. 209.

Thallus erect, filiform, attached below by a dilated basal cell or a few-celled disk, above filamentous or more or less thickened and terete or dilated and foliaceous; cells at first arranged in a single row, later sometimes divided longitudinally, or occasionally even forming a one-layered disk; asexual propagation by naked monospores which are passively distributed; monosporangium formed from the upper, smaller, denser of two cells arising from the unequal division of a vegetative cell by an oblique wall; sexual reproduction by apparently nonmotile spermatia and eggs; antheridia formed from portions of vegetative cells in a way analogous to the monosporangia, the contents being divided into numerous minute spermatia; eggs arising singly from the entire contents of vegetative cells; fertilized egg forming a one or few celled fruit.

About five species, all marine.

Erythrotrichia carnea (Dillwyn) J. Agardh. Fig. 24.

Conferva carnea, Dillwyn, 1809, pl. 84.
Conferva ceramicola, Lyngbye, 1819, p. 144, pl. 48 D.
Erythrotrichia ceramicola, Areschoug, 1850, p. 210.
Erythrotrichia carnea, J. Agardh, 1882, p. 15, pl. 19.
Erythrotrichia ceramicola, Farlow, 1882, p. 113.
Erythrotrichia ceramicola, De Toni, 1897, p. 24.
P. B.-A. No. 1642 (*Erythrotrichia ceramicola*).

Thallus epiphytic, consisting of erect, flaccid filaments 1 to 30 mm. long, composed of single, unbranched rows of cells, attached by the expanded, colorless basal cell of each filament; cells 12 to 20 mic. long, 12 to 18 mic. wide, rose or flesh color; monospores spherical, 15 to 18 mic. in diameter.

Warm and temperate North Atlantic; Alaska; Adriatic.

Common in small quantities on *Dictyota dichotoma* and *Padina vickersiæ*, Beaufort, N. C., June to December, and on *Dictyota dichotoma* at Marshallburg, N. C. On old specimens of these species it becomes very abundant, either mixed with other filamentous epiphytic algæ or covering the entire host plant with a pure growth.

Genus 5. **Erythrocladia** Rosenvinge.

Erythrocladia, Rosenvinge, 1909, p. 71.

Thallus horizontally expanded, growing on or in other algæ, composed of branched filaments irregularly or more or less regularly radiating from a common center, separate from each other in the beginning, later fusing more or less to form a thin disk consisting of a single layer, filaments growing at the apices; asexual propagation by naked monospores which are passively distributed; monosporangium formed from the denser of two cells arising from the unequal division of a vegetative cell by an oblique wall; sexual reproduction by apparently nonmotile spermatia and eggs; spermatia (at least in some cases) raised slightly above the surface; carpogonium furnished with a short beak or trichogyne projecting slightly beyond the surface; fertilized egg forming a small fruit (sporocarp) bearing one or more carpospores.

Four species, known only from Denmark, North Carolina, and, with some doubt, from St. Thomas, West Indies.

KEY TO SPECIES.

Mature thallus consisting of filaments forming an irregular suborbicular structure, the filaments somewhat compact and coalescent at the center and radiating from this toward the edges, cells 8 to 25 mic. long and 3 to 12 mic. broad.....1. *E. recondita* (p. 467).

Mature thallus consisting of straggling or irregularly radiating filaments, not forming a compact structure at the center, cells 9 to 40 mic. long and 6.5 to 15 mic. broad..2. *E. vagabunda* (p. 467).

1. **Erythrocladia recondita** Howe and Hoyt. Pl. CXVI, fig. 1; Pl. CXVII, figs. 1–5.

Erythrocladia recondita, Howe and Hoyt, 1916, p. 112, pl. 12, figs. 1–5; pl. 13, fig. 1.

Thallus endophytic or pseudo-epiphytic, creeping in the superficial cell walls of other algæ, consisting at first of free, irregularly radiating, and irregularly branching filaments, soon forming a more or less compact central region by the coalescence of the central filaments, the entire structure reaching a diameter of 0.2 to 1.5 mm. and usually remaining single-layered; branching lateral or somewhat dichotomous, the lateral branches, especially in the younger parts, often spreading; cells varied and irregular in form, in surface view mostly oblong, quadrate, ovate, or fiddle shaped, often curved, forked, or irregularly one or two lobed, 8 to 25 mic. long, 3 to 12 mic. broad; male and female organs borne on the same individual; spermatia ovoid, 2 to 4 mic. in diameter, more or less exserted by slender stalks about 1 mic. broad; carpogonium furnished with a beak or trichogyne exserted about 4 to 8 mic.; sporocarp forming a single carpospore (or, rarely, two), these ovoid, oblong, or irregular, mostly 8 to 19 mic. in maximum diameter; nonsexual spores unknown.

Endemic.

Fairly abundant in the superficial cell walls of *Dictyota dichotoma* growing in the harbor, Beaufort, N. C., especially on Fort Macon jetties, summer and autumn; on Dictyota and other algæ and in the stolons of hydroids growing on these, dredged from the coral reef offshore, Beaufort, N. C., August, 1914.

This alga is entirely invisible to the naked eye and will not be seen even under the microscope unless a careful search is made. When seen, it appears as a more or less definite mass of clear, minute filaments closely adherent to the surface of the host. Its color is scarcely distinguishable, it apparently being so neutral in this respect as to show the color of the host. It can be made clearly evident by staining with iodine dissolved in potassium iodide. It will not be confused with any other species found in the harbor. It is unknown outside of this region.

2. **Erythrocladia vagabunda** Howe and Hoyt. Pl. CXVI, fig. 2; Pl. CXVII, figs. 6–11.

Erythrocladia vagabunda, Howe and Hoyt, 1916, p. 115, pl. 12, figs. 6–11, pl. 13, fig. 2.

Thallus endophytic or pseudo-epiphytic, creeping in the superficial cell walls of other algæ, consisting chiefly of irregularly branching, uniaxially elongate, or irregularly radiating filaments, finally spreading over areas 0.75 to 2.25 mm. long or broad, often anastomosing or appearing to anastomose, and commonly forming here and there small irregular compact patches 2 to 6 cells broad; branching mostly lateral, rarely somewhat dichotomous, often spreading or rectangular; cells for the most part irregularly oblong in surface view, often curved or one or two lobed, 9 to 40 mic. long, 6.5 to 15 mic. broad; sporocarps forming single carpospores (rarely two?), these ovoid, oblong, or irregular, mostly 12 to 25 mic. in maximum diameter; nonsexual spores unknown.

Endemic.

Fairly abundant in the superficial cell walls of *Dictyota dichotoma* dredged from the coral reef offshore, Beaufort, N. C., August, 1914.

This species is not visible to the naked eye and will not be noticed, even under the microscope, unless a careful search is made. Staining with iodine dissolved in potassium iodide will help to make it evident. It has not been found in the harbor. If it should be found there, it will not be mistaken for any other alga except *E. recondita*. From this it is distinguished by its more straggling habit, its larger cells, and its more rectangular branches. It is not known from any other region.

Plants apparently belonging to this species were found on *Sargassum filipendula* dredged from the coral reef at the same time as the Dictyota.

Class 2. Florideæ Lamouroux.

Eu-Florideæ, De Toni, 1897, p. 33.

Thallus multicellular, exceedingly various in size, habit, and structure; asexual propagation by nonmotile spores produced (usually four—tetraspores, sometimes one, two, or many) in special sporangia; tetrosporangia divided zonately, cruciately, or triangularly; sexual reproduction by nonmotile spermatia and eggs borne in special antheridia and carpogonia, respectively; antheridia variously formed, producing numerous minute spermatia; carpogonia bearing single eggs which, when fertilized, give rise

to spore-bearing filaments directly or in conjunction with auxiliary cells; auxiliary cells present, except among Nemalionales, associated with the carpogonium or occurring separately in the thallus, sometimes not developed until after fertilization; tufts of spore-bearing filaments (gonimoblasts), formed as result of fertilization, entire or divided into several parts (gonimolobes); each filament giving rise to a single nonmotile spore (carpospore) from each of one or more of its apical cells; gonimoblasts naked or inclosed by sterile jackets, forming cystocarps opening by apical pores.

KEY TO ORDERS.

a. Gonimoblasts formed directly from the fertilized eggs.....1. NEMALIONALES (p. 468).
aa. Gonimoblasts formed with the interposition of auxiliary cells.....*b*.
b. Auxiliary cells usually united with carpogenic branches into definite procarps, cystocarps usually immersed in the frond, gonimoblasts not attached to a basal placenta .....2. GIGARTINALES (p. 476).
bb. Mother cells of auxiliary cells united with carpogenic branches into definite procarps, the auxiliary cells usually formed only after fertilization, cystocarps not immersed in the frond, gonimoblasts attached to a basal placenta.....3. RHODYMENIALES (p. 482).
bbb. Auxiliary cells occurring separately in the thallus, not united with carpogenic branches into procarps, cystocarps usually immersed in the frond, gonimoblasts usually attached to a basal placenta.....4. CRYPTONEMIALES (p. 515).

Order 1. **Nemalionales** Schmitz.

Nemalioninæ, De Toni, 1897, p. 34.

Gonimoblast formed directly from the fertilized egg itself,[a] consisting of an upright, small, or more or less expanded, branching tuft, whose branches in some cases fuse with neighboring cells of the thallus or with specially formed auxiliary cells.

KEY TO FAMILIES.

Gonimoblast a compressed tuft of segmented branched filaments, whose terminal cells form carpospores, external or immersed, not inclosed by a sterile jacket. .1. HELMINTHOCLADIACEÆ (p. 468).
Gonimoblast a widely expanded tuft of segmented branched filaments, some segments fusing with neighboring cells; the apices of these fertile filamentous branches confluent into an hymenium from which the carpospores arise.....2. GELIDIACEÆ (p. 474).

Family HELMINTHOCLADIACEÆ (Harvey) Schmitz.

Nemalionaceæ Howe.

Thallus filamentous, terete, or compressed, variously branched, usually gelatinous, sometimes incrusted with lime; structure conspicuously filamentous, central axis usually present; asexual propagation by monospores, dispores, tetraspores, or polyspores; antheridia scattered or clustered on the apices of short, filamentous branches, often developing from ordinary vegetative cells, each producing one or a few spermatia; carpogonia borne at the apices of short specialized or unspecialized, filamentous branches; the fertilized egg gives rise directly to a tuft of segmented, branched filaments (gonimoblast) whose terminal cells (and sometimes subterminal ones also) form carpospores; sporocarp external or immersed, usually naked, sometimes surrounded by a few sterile filaments;

[a] Doubt may be thrown on this point by the work of Svedelius (1915), showing the presence of auxiliary cells in Scinaia. The retention of this genus in the Nemalionales would, however, break down the distinction between the Nemalionales and the Gigartinales, necessitating their combination into a single order characterized (?) by the presence or absence of auxiliary cells. It seems, as far as our present knowledge goes, therefore, that Scinaia and other genera having these structures should be transferred to the Gigartinales, and that the Nemalionales should be retained as now understood, including the genera lacking auxiliary cells.

sporangia and sexual organs on the same or different individuals; antheridia and carpogonia on the same or different individuals.

About 110 species, fresh water and marine, in temperate and tropical regions.

Genus **Acrochætium** Nægeli.

Acrochætium, Nægeli, 1861, p. 402.
Trentepohlia, Farlow, 1882, p. 108.
Chantransia, De Toni, 1897, p. 67.

Thallus filamentous, segmented, monosiphonous, irregularly branched, increasing in length by transverse division of the apical cell, branches often terminating in hairs; asexual propagation by monospores, occasionally by dispores, tetraspores, or polyspores, sporangia occurring singly or in tufts, lateral and sessile on the branches or terminal on short ramuli; sexual reproduction by eggs borne in carpogonia, and spermatia; antheridia borne in tufts at the apices of short branches; carpogonia borne singly at the apices of one to three celled branches; sporocarp naked, bearing a tuft of filaments whose terminal cells form carpospores; sporangia and sexual organs borne on the same or different individuals; monœcious or dicœcious; sexual reproduction apparently lacking in some species.

About 60 species, marine and fresh water.

This genus has had a varied nomenclature. Originally described as Acrochætium, it has been called Chantransia by many authors. For a time the group, as now recognized, was separated into two genera—the species with sexual fruit being placed under Chantransia and those with sexual fruit unknown being referred to Acrochætium. It is now generally agreed that this distinction is not valid, but there is still disagreement as to the proper name for the genus. As was pointed out by Howe (1914a, p. 83), the name Chantransia has been used for several other forms and is, moreover, a violation of all the codes of nomenclature. The name Acrochætium is therefore to be preferred, both because of its priority and because it is less likely to cause confusion.

Some of the species are distinguished with ease, but others are separated by inconspicuous, apparently intergrading, characters, and are determined with great difficulty. It is often impossible to decide with certainty to what species a single given plant should be referred.

KEY TO SPECIES.

a. Plants growing in hydroids.....6. *A. infestans* (p. 473).
aa. Plants growing on or in other algæ.....*b*.
b. Upright filaments arising from an external basal disk.....7. *A. virgatulum* (p. 473).
bb. Upright filaments arising in part from an external or internal basal filament.....*c*.
c. Basal filament entirely internal, original basal cell conspicuous, sporangia, antheridia and carpogonia borne on different plants.....5. *A. corymbiferum* (p. 473).
cc. Basal filament mostly external, original basal cell inconspicuous, sporangia, antheridia and carpogonia borne on the same plants.....4. *A. affine* (p. 471).
bbb. Upright filaments arising from a single basal cell or from a few secondary basal cells.....*d*.
d. Plants not visible to naked eye.....1. *A. parvulum* (p. 470).
dd. Plants visible to naked eye as a fine velvety fringe or mat.....*e*.
e. Basal cell pear shaped, penetrating the host to a depth of 12 to 20 mic....4. *A. affine* (p. 471).
ee. Basal cell spherical or nearly so, 12 to 25 mic. in diameter, not conspicuously penetrating the host, usually bearing several upright filaments, branches often elongated and tapering toward apices.....3. *A. hoytii* (p. 470).
eee. Basal cell spherical, 5 to 8 mic. in diameter, superficial, usually bearing a single upright filament, branches not greatly elongated, not tapering toward apices .....2. *A. dufourii* (p. 470).

1. **Acrochætium parvulum** (Kylin) comb. nov. Fig. 25.

Chantransia parvula, Kylin, 1906, p. 124, f. 9.
P. B.-A. No. 1999. (*Chantransia hallandica* var. *parvula* (Kylin) Rosenvinge.)

Plants 70 to 185 mic. tall, usually 100 to 150 mic.; basal cell 7 to 15 mic. in diameter, usually 7 to 10 mic., bearing 1 to 6 erect filaments; cells 4 to 10 mic. in diameter, usually 6 to 7 mic., 1 to 3.5 diameters long, usually 1.5 to 2 diameters; branching frequent, secund or opposite; branches short, tapering, nearly every cell bearing a short apical hair which is frequently pushed to one side and may be shed; sporangia 6 to 9 by 8 to 14 mic., usually 6 to 8 by 12 to 13 mic., usually sessile, sometimes on a one-celled pedicel, frequently opposite; sexual organs borne on the same individuals as the sporangia or lacking.

Scandinavia.

Abundant on *Polysiphonia harveyi*, sea buoy, Beaufort, N. C., July 27, 1909.

This species may be easily distinguished from the others occurring at Beaufort by its habit and its small size. Although all the specimens observed were sterile, the characters of the plants agree so closely with the published descriptions and figure of *Chantransia parvula* Kylin that it seems better to refer it to this species than to describe it as a new one. In the Beaufort specimens there is usually only one erect filament arising from the basal cell, although occasionally as many as four have been observed. It has not previously been reported from any region outside of Scandinavia.

2. **Acrochætium dufourii** Collins. Fig. 26.

Chantransia dufourii, Collins, 1911, p. 187.
Acrochætium dufourii, Collins, P. B.-A. No. 1594.
P. B.-A. Nos. 1594, 2087.

Plants 200 to 600 mic. tall, usually 250 to 350 mic.; basal cell (original spore) 5 to 8 mic. in diameter, bearing 1 to 3 erect filaments; cells 4 to 5 mic. in diameter, 2 to 5 diameters long; branching rather sparse, sometimes opposite or alternate, more commonly secund; branches erect, not very closely set, not tapering at their apices; sporangia 5 to 6 by 7 to 10 mic., sessile or on a one-celled pedicel, on the main filament, or on a branch, usually in secund series; sexual organs unknown.

North Carolina; Bermuda.

Abundant on *Sargassum filipendula*, Fort Macon jetty, Beaufort, N. C., usually in company with *Erythrotrichia carnea* and often with *Gomiotrichum alsidii*, summer and autumn.

This species most nearly resembles *A. hoytii*, from which it is distinguished by its smaller size, its smaller, superficial basal cell, its less frequent branching with consequent more open habit, and its usually less elongated branches not tapering toward the apices. There is usually only one upright filament from the basal cell, but sometimes two or three are observed. Two or three plants resembling *A. dufourii* in other respects have been observed on *Dictyota dichotoma* arising from short, horizontal, external filaments with no evident basal cell. If these plants should be referred to this species it would show a behavior here similar to that found in *A. affine*, where, apparently, the basal cell may form horizontal filaments and may itself become inconspicuous or disappear. In view of the small number of plants observed in this condition, however, the author has been unwilling to change the limits of the species to include these.

This species is not known outside of North America, although, according to Collins (1911), it appears to be the plant of the Mediterranean distributed by Dufour as *Callithamnion lenormandi* in Erbario Crittogamico Italiano, No. 953, but not *C. lenormandi* Suhr, in Kuetzing, 1849a, p. 640.

3. **Acrochætium hoytii** Collins. Figs. 27 and 28.

Acrochætium hoytii, Collins, 1908, p. 134.
Chantransia hoytii, Collins, 1911, p. 186.
P. B.-A. No. 1540.

Plants 0.25 to 1.3 mm. tall, usually 0.5 to 0.65 mm.; basal cell (original spore) 12 to 25 mic. in diameter, spherical or somewhat elongate vertically, then up to 30 mic. long, superficial or slightly embedded in the host, bearing 1 to 4 erect filaments, very rarely forming one or more secondary basal cells; cells of main filaments 5 to 7 mic. in diameter, usually 2 to 4 diameters long; branching rather frequent below, usually rarer above, often secund; ultimate branches usually elongated, often simple or nearly so, usually tapering gradually toward the apices; sporangia lateral on the upper part of the filament and branches, usually on one-celled pedicels, sometimes sessile, usually secund, oblong, about 5 to 6 by 11 to 15 mic.; cystocarps very rare, borne on short pedicels near the base of the branches.

Very abundant on *Dictyota dichotoma* on Fort Macon jetties, Beaufort, N. C., less abundant on Dictyota in harbor, usually unmixed with other algæ, summer and autumn.

Endemic.

This species appears to be related to *A. dufourii* on the one side and to *A. affine* on the other. In fact, these three species seem to form an intergrading group, so that distinctions are frequently very difficult. From *A. dufourii* it is distinguished by its usually larger size, larger, sometimes slightly embedded basal cell, more abundant branching with consequent denser habit, and its usually more elongated branches tapering toward the apices. The germinating spore seems to not merely remain distinct throughout the life of the plant, but to increase to many times its original size, and may send up as many as four erect filaments. It is distinguished from *A. affine* by its smaller size, its smaller and shorter cells, its more nearly spherical and more superficial basal cell, the absence of horizontal filaments, the abundance of sporangia, and the great scarcity of cystocarps. The basal cell usually remains unchanged except for its increase in size, and forms, at most, a few secondary basal cells which do not give rise to upright filaments. The general habit resembles *A. corymbiferum* but it is readily distinguished from that species by the differences in the basal portions of the plants and in the formation of the organs of reproduction. Its habit is sometimes very dense.

Small plants of *A. hoytii* are especially difficult to distinguish from *A. dufourii* since they are often sparsely branched and do not bear elongated, tapering branches. With such plants the principal distinguishing character is the size of the basal cell, but even with this it is not always easy to determine to which of these species a given plant should be referred.

4. **Acrochætium affine** Howe and Hoyt. Pl. CXIX.

Acrochætium affine, Howe and Hoyt, 1916, p. 118, pl. 15.

Plants 1 to 3.5 mm. tall; basal cell (original spore) subglobose or ellipsoid, mostly 14 to 26 mic. in diameter, finally becoming subpyriform and 20 to 33 mic. high through the development of a subcylindric obtuse or truncate foot penetrating the host for about 10 to 24 mic., the basal cell remaining simple or occasionally developing one or more smaller accessory cells, or sometimes sending out short, creeping, often more or less immersed filaments 2 to 5 cells long, these very rarely forming a small imperfect basal disk, the secondary basal cells often sending up erect filaments; erect primary filaments 1 to 4 (usually 2 to 3) from the primary basal cell, 6 to 14 mic. in diameter, often subdichotomous or subtrichotomous at the distal end of the first cell, erect filaments from secondary basal cells 1 to 4 (when present), commonly more slender, 4 to 8 mic. in diameter, all filaments somewhat rigid below, becoming flexuous above, rather sparingly and irregularly branched, the branching subdichotomous or distinctly lateral, ultimate branches 3 to 5.5 mic. in diameter, mostly elongate-virgate, terminal hairs often present, but rather inconspicuous; cells of filaments cylindric, firm-walled, mostly 3 to 9 times as long as broad; sporangia uncommon, lateral on one-celled pedicels, lateral and sessile, or sometimes terminal on main branches, 18 to 27 mic. by 10 to 18 mic.; antheridia usually close to the procarp, lateral or somewhat terminal, solitary or in groups of 2 to 3; cystocarps abundant, mostly 3 to 8 spored, carpospores 13 to 26 mic. by 8 to 18 mic.; antheridia, cystocarps, and (sometimes at least) sporangia occurring on the same individual.

Abundant on *Dictyota dichotoma* and occasional on *Spyridia filamentosa* and other hosts dredged from the coral reef offshore from Beaufort, N. C., August, 1914.

Endemic.

This species most nearly resembles *A. hoytii*, which is borne on the same host in Beaufort Harbor. From this it differs in its larger size, its larger and longer cells, its more elongated and more embedded basal cell, its occasional formation of horizontal filaments, the infrequent formation of sporangia, and the relatively abundant cystocarps produced on the same plants. Its general habit resembles *A. coymbiferum*, from which it is distinguished by its larger, more persistent, partially embedded basal cell, the upright filaments often arising entirely from this, by the less abundant cystocarps, these, the antheridia, and the sporangia being borne on the same plants, and by the fact that the horizontal filaments, when present, are mostly external. From *A. dufourii* it is distinguished by its larger size, its larger, partially embedded basal cell, its more abundant branching, the branches tapering toward the apices, and by its fairly abundant production of cystocarps.

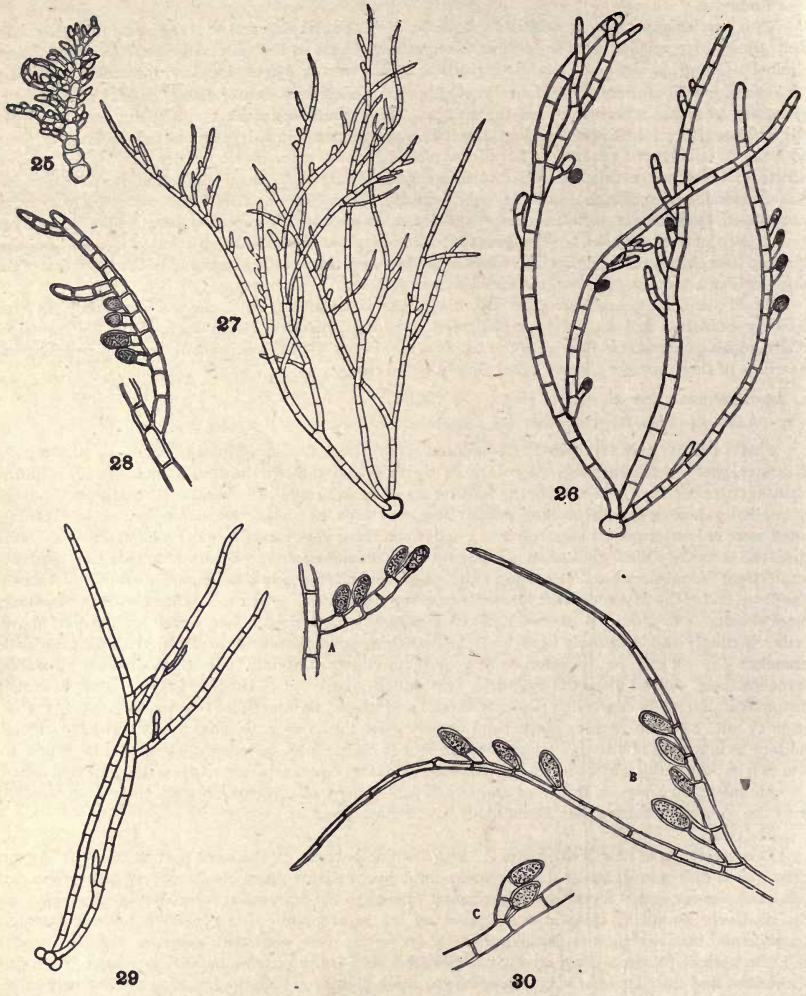


Fig. 25.—*Acrochætium parvulum*, × 189.

Fig. 26.—*Acrochætium dufourii*, showing monosporangia and spore, drawn from cotype, × 189.

Fig. 27.—*Acrochætium hoytii*, drawn from cotype, × 98.

Fig. 28.—*Acrochætium hoytii*, showing monosporangia, × 189.

Fig. 29.—*Acrochætium virgatulum*, × 98.

Fig. 30.—*Acrochætium virgatulum*, showing monosporangia, × 257.

5. **Acrochætium corymbiferum** (Thuret) Collins and Hervey.

Chantransia corymbifera, Thuret, in Le Jolis, 1863, p. 107.
Chantransia corymbifera, De Toni, 1897, p. 69.
Acrochætium corymbiferum, Collins and Hervey, 1917, p. 97.
P. B.-A. Nos. 1040, 1880 (*Chantransia corymbifera*); not No. 192.

Plants 2 to 3 mm. tall; basal cell (original spore) 12 to 15 mic. in diameter, sending down into the host a branching filament about the size of the erect filament but more irregular and contorted; erect filaments arising from the basal cell and the secondary internal filament; cells 8 to 16 mic. in diameter, 3 to 10 diameters long; branches few below, more abundant above, alternate or somewhat secund, virgate, sparingly branched; sporangia sessile or shortly pedicellate near the bases of the branches; cystocarps forming dense, hemispherical clusters of naked spores near the bases of the branches; antheridia forming small, dense, short-pedicellate clusters at various points on the branches; sporangia, cystocarps, and antheridia produced on different plants.

California; Bermuda; England; Atlantic coast of France.

Very abundant on one plant of *Dasya pedicellata* growing in harbor, Beaufort, N. C., May, 1907.

This species has not previously been reported from our coast. While found on only one plant, it was probably more abundant, as it was completely hidden by the hairs of its host. No sporangia have been observed here. The habit of this species resembles that of *A. hoytii* (figs. 27 and 28), but it is easily distinguished from the latter by its internal basal filaments and its abundant cystocarps. From *A. affine* it is distinguished by its smaller, more superficial basal cell, by its abundant internal horizontal filaments, and by its production of sporangia, antheridia, and cystocarps on different plants.

6. **Acrochætium infestans** Howe and Hoyt. Pl. CXVIII.

Acrochætium infestans, Howe and Hoyt, 1916, p. 116, pl. 14.

Plants consisting of extensive branched basal filaments growing in hydroids and sending out more or less numerous external filaments; interior filaments tortuous, intricate, serpentine, or labyrinthine, or sometimes straight for considerable distances, mostly 2 to 5.5 mic. in diameter, the branching very irregular, lateral, subdichotomous, or very rarely opposite, commonly divaricate from near the middle of a cell, the branches often somewhat curved, the interior cells mostly 12 to 60 mic. long, 3 to 18 times as long as broad, commonly curved or contorted and of irregular or fluctuating diameter, sometimes expanded to form, with cells of adjacent filaments, a subparenchymatous layer composed of irregularly shaped cells 9 to 13 mic. wide and 7 to 14.5 mic. long, the terminal cells of branches often enlarged, somewhat hooked at the ends, irregularly club-shaped, or somewhat forking, sometimes attaining a diameter of 7 to 8 mic.; external filaments up to 90 mic. tall (or 230 mic., including hairs), the simpler ones consisting of a single pedicel cell bearing 1 to 3 sporangia (or, very rarely, the exserted sporangium sessile on an internal filament), the larger ones showing 1 to 9 short, 1 to 3 celled, rarely secund branches, the cells 4.5 to 6.5 mic. in diameter, 1 to 2 diameters long; very slender, colorless hairs commonly present on the larger external filaments, flexuous and attaining a length of 125 to 170 mic.; sporangia terminal or lateral, solitary or in groups of two or three, ovoid or ellipsoid, 6 to 8.5 by 10 to 14 mic.; sexual reproduction unknown.

Abundant on *Clytia minuta* (and other hydroids?) growing on *Dictyota dichotoma* and *Sargassum filipendula* dredged from coral reef offshore, Beaufort, N. C., August 11, 1914.

Endemic.

The hydroids acting as hosts for this alga were usually not obtained in sufficiently good condition to warrant determination. Three of the best of these, kindly examined by Prof. C. C. Nutting, were identified as (1) *Clytia minuta*, (2) probably *Plumularia sp.*, (3) *Campanularian hydroid.* The internal filaments grow within the ectosarc and are abundant throughout the stalks of the hydroids, occurring to a less extent in the rhizomes and hydranths. Various stages, from the ungerminated spore to extensive networks of filaments, have been observed.

7. **Acrochætium virgatulum** (Harvey) Bornet. Figs. 29 and 30.

Callithamnion virgatulum, Harvey, in Hooker, 1833, p. 349.
Callithamnion virgatulum, Harvey, 1853, p. 243.
Trentepohlia virgatula, Farlow, 1882, p. 109, pl. 10, f. 3.
Chantransia virgatula, De Toni, 1897, p. 69.
Acrochætium virgatulum, Bornet, 1904, p. XXII.
Acrochætium virgatulum, Collins, 1906, p. 193.
A. A. B. Ex. No. 157 (*Chantransia virgatula* f. *luxurians*).
P. B.-A. Nos. 741 (*Chantransia virgatula* f. *tenuissima*). 1594.

Plants 0.8 to 2.6 mm. tall, usually 1.5 to 2 mm.; one to many filaments arising from a basal disk; cells 7 to 14 mic. in diameter below, 4 to 10 mic. in diameter above, 3 to 5 diameters long below, 4 to 6 diameters long above; filaments long and straight with rather few long, straight, erect branches, usually terminating in a very slender hair; short ramuli, mostly 1 to 3 celled, abundant, scattered, opposite or in short secund series, bearing either hairs or terminal sporangia; sporangia also sessile on the branches, occupying the places of ramuli, 10 to 12 by 20 to 24 mic.; sexual organs unknown.

Temperate North Atlantic.

Fairly abundant on *Gracilaria multipartita*, *G. confervoides*, *Agardhiella tenera*, *Petalonia fascia*, and *Padina vickersiæ* on Fort Macon and Shackleford jetties and in harbor, Beaufort, N. C., throughout the year.

This species may be distinguished by its basal disk bearing one or more erect filaments and its long, straight branches, which are often subsimple. In the typical form the branches bear short ramuli or spores on nearly every cell, and numerous hairs, the hairs not being formed by a gradual tapering of the branch but appearing abruptly at the apex of a cell of about the same size as the preceding ones. But in some forms the branches are long and tapering, without hairs and with infrequent branching.

In the Beaufort specimens hairs are lacking and short ramuli are infrequent. In some specimens the branches taper gradually to the apices, in some they taper slightly, while in some specimens, similar to the preceding ones in other respects, they are nearly of uniform diameter throughout. In the majority of cases the filaments are long, straight, and sparingly branched, sometimes being entirely simple; sporangia are borne in short secund series on the main branches, usually being lateral and sessile, less often terminating longer or shorter ramuli. In these respects the Beaufort specimens resemble f. *tenuissima* Collins (1906, p. 194). From this they differ, however, in that the diameter of the filaments is greater and the basal disk is larger, sometimes almost forming a continuous layer of considerable extent and approaching in this respect f. *luxurians* Collins.

This is the southern limit reported for the species on our coast, but it probably extends farther.

Acrochætium sp.

Plants differing from all the above-mentioned species and not certainly referable to any described species were found in abundance on *Sargassum filipendula*, *Agardhiella tenera*, and, in less amount, on *Gracilaria confervoides* dredged from the coral reef offshore, July and August, 1915. In view, however, of our ignorance of the variation of plants belonging to this genus when growing on different hosts or under different conditions it has not seemed wise to describe these as a new species.

Of the seven identified species of this genus found at Beaufort five have been observed on only one host—*A. hoytii* and *A. affine* on *Dictyota dictotoma*, *A. parvulum* on *Polysiphonia harveyi*, *A. corymbiferum* on *Dasya pedicellata*, and *A. infestans* on hydroids. *A. dufourii* has been observed on *Sargassum filipendula* and apparently also on *Dictyota dichotoma*, while *A. virgatulum* has been found on five species of algæ, but not on the same host occupied by any of the other species of Acrochætium.

Family 2. GELIDIACEÆ (Kuetzing) Schmitz.

Frond terete or compressed, usually laterally branched, with fairly evident filamentous structure and usually thick and firm texture, traversed by a segmented axial tube (often indistinct in the older parts), from which arise branched lateral filaments composing the cortex; tetrasporangia zonately, cruciately, or triangularly divided, grouped in special portions of the thallus or scattered in the outer rind; antheridia occurring in a more or less widely expanded layer over the surface of special portions of the thallus or forming small, scattered tufts arising from the cortical filaments; carpogonia borne beneath the surface on the cortical filaments or laterally on the central axis, often occurring in special fertile portions of the thallus; the fertilized eggs give rise directly (often after fusion with one or more neighboring—quasi auxiliary—cells) to gonimoblasts composed of much-branched, expanded filaments; ends of

these fertile filamentous branches confluent into an hymenium on the apices of which the carpospores are borne singly or, rarely, in short chains.

About 90 species, all marine, mostly in warm and temperate seas.

Genus Gelidium Lamouroux.

Gelidium, Lamouroux, 1813, p. 40.

Frond terete or flattened, pinnately decompound, of tough, firm texture, with thick dense rind; central axis composed of a segmented, longitudinal filament, from which arise numerous obliquely longitudinal filaments verticillately arranged and densely coalescent into a proper cortex, outer rind cellular, with larger cells toward the center, smaller ones toward the periphery; central axis with distinct apical cell. Tetrasporangia formed in sori immersed in local swellings on both sides of the thallus below the apices of ordinary pinnæ, rotund, cruciately divided; cystocarps immersed in swollen portions below the apices of ordinary pinnæ, usually divided by a longitudinal partition into two chambers, one on each side of the flattened thallus, each chamber communicating with the exterior by a separate pore, carpospores obovate arising singly from the hymenial layer, pericarp raised up from the hymenial layer but joined with it by numerous simple filaments, antheridia occurring in superficial patches; tetrasporangia and cystocarps occurring on separate plants.

About 25 species recognized, many separated by inconspicuous, probably doubtful, characters; in warm and temperate seas.

KEY TO SPECIES.

Upright branches 1 to 2 cm. tall or less, comparatively thick, flattened, much branched.....
.....1. *G. coerulescens* (p. 475).
Upright branches 2 to 3.5 cm. tall, slender, subterete, sparsely branched.....2. *G. crinale* (p. 475).

1. **Gelidium cœrulescens** Kuetzing. Pl. XCV, fig. 1.

Gelidium cærulescens, Kuetzing, 1868, Bd. 18, p. 19, pl. 56, f. 2.

Thallus erect, flattened, arising from a fine, filiform, creeping base, 1 to 2 cm. tall, 0.3 to 0.5 mm. wide in widest portion; branching decompound, distichous from the margins, sparse below, more or less dense above; texture fleshy gelatinous; color, dark purplish brown.

West Indies; New Caledonia.

Very abundant, forming low, dense masses on jetties, walls, shells, and stones at Fort Macon, Beaufort, N. C., and along town front from about 10 to 70 cm. above low tide line, April to October, probably throughout the year.

This species was identified by Mr. Collins on the basis of a Guadeloupe specimen determined by Crouan, and it may perhaps be questioned whether it is really the species described by Kuetzing.

2. **Gelidium crinale** (Turner) J. Agardh. Pl. XCV, fig. 2.

Fucus crinalis, Turner, 1808, pl. 198.
Gelidium crinale, J. Agardh, 1876, p. 546.
Gelidium crinale, Farlow, 1882, p. 158.
Gelidium crinale, De Toni, 1897, p. 146.
P. B.-A. Nos. 195, 2089.

Primary frond decumbent, about 0.5 mm. in diameter, giving off erect branches, terete or sometimes slightly flattened, slender, 2 to 7 cm. tall, sparingly branched, sometimes almost simple; color purple or yellowish brown.

Warm and temperate waters generally, occurring on our coast from Maine to Florida.

Fairly abundant between tide lines on Fort Macon jetties, Beaufort, N. C., April to August, 1908, probably occurs throughout the year, abundant on submerged shells in Newport River near "Green Rock," August, 1906; abundant in Core Sound near Leckly's Island July, 1908; fairly abundant in Pamlico Sound on shells and posts between tide lines, Ocracoke, N. C., August, 1907; one specimen on submerged shell, Pawleys Island, near Georgetown, S. C., August, 1909.

This species varies considerably in the size of the clusters, the height of the upright branches, the amount of branching, and the amount of flattening. The clusters may be dense or loose, the upright branches may be 2 to 7 cm. tall; branching is usually sparse and irregular, but may be fairly regularly pinnate at the apices, or the fronds may be entirely unbranched; they are usually almost terete, but may show slight, distinct flattening.

The two species occurring in this region can usually be easily distinguished as follows: *G. cærulescens* forms dense mats, has a dense, compact habit, with the upright branches short (8 to 15 mm. tall), flattened, comparatively wide, much branched in a fairly regular, decompound manner; *G. crinale* usually occurs in sparse clusters, has a slender, open habit, with the upright branches comparatively long (2 to 3 cm.), rounded or very slightly flattened, slender, usually sparsely and irregularly branched, sometimes simple, sometimes fairly regularly pinnate.

Gelidium sp. indet.

A single indeterminable fragment from Bogue Beach, Beaufort, N. C., September, 1905, is 4 cm. long, about 0.5 mm. wide, and 0.1 mm. thick, narrow, flattened, sparsely pinnate, pink. This may be a battered specimen of *G. corneum* or may be a portion of one of the larger, more tropical species.

Order 2. **Gigartinales** Schmitz.

Gigartininæ, De Toni, 1897, p. 169.

Carpogonial filaments and auxiliary cells usually occurring together in pairs, forming definite procarps, sometimes occurring singly in the thallus. Cystocarps usually immersed in the frond. Gonimoblast arising from an auxiliary cell after the fertilized egg has fused with this by means of a usually short carpogonial process, not attached to a basal placenta.

KEY TO FAMILIES.

Gonimoblast consisting of a richly branched tuft whose branches are distributed without order within the inclosing structures; tetrasporangia usually cruciately divided . 1. GIGARTINACEÆ (p. 476).
Gonimoblast divided into several lobes radiating inwardly in all directions; tetrasporangia zonately divided . . . . . 2. RHODOPHYLLIDACEÆ (p. 478).

Family 1. GIGARTINACEÆ Schmitz.

Frond terete, flattened, or foliaceous; dichotomously or pinnately branched, sometimes simple or irregularly lobate; structure cellular or filamentous, usually plainly fanlike at apices; tetrasporangia scattered over the frond in the outer cortex, or grouped in sori and immersed in the thallus, or borne in special protuberances (nemathecia), usually cruciately, sometimes zonately, divided; antheridia usually in patches more or less widely distributed over the surface of the thallus, sometimes in flasklike cavities sunk in the outer cortex and opening to the exterior; carpogonia usually numerous on the fertile portions of the thallus, usually produced singly on a three-celled carpogenic branch associated with an auxiliary cell into a definite procarp; the fertilized egg fuses with the auxiliary cell by a short process; the latter then gives rise to the gonimoblast, consisting of a tuft of filaments richly branched in all directions; the branches of this tuft are themselves richly branched and interwoven to form a structure of fertile and sterile filaments almost without order; the apical cells of the fertile filaments (and sometimes subapical ones also) form carpospores which lie in groups usually without order; fruits often inclosed by a sterile jacket; these cystocarps usually occur scattered over the thallus, immersed or more or less prominent on one or both sides, and communicate with the exterior by one or more often inconspicuous pores.

About 275 species, all marine, especially in cold and temperate seas.

KEY TO GENERA.

Frond terete, dichotomous, cartilaginous..... 1. Gymnogongrus (p. 477).
Frond parasitic, appearing from the exterior as a cushionlike nemathecium on Gymnogongrus.
..... 2. Actinococcus (p. 477).

Genus 1. **Gymnogongrus** Martins.

Gymnogongrus, Martins, 1833a, p. 27.

Frond terete or flattened, repeatedly dichotomous, often also with more or less numerous lateral branches, of fleshy-leathery or horny consistency; tetrasporangia unknown; procarps borne on fertile upper segments of the frond in flattened prominences; cystocarps immersed in the frond, more or less prominent on one or both sides; containing a compound "nucleus" bearing numerous rounded carpospores without order among sterile filaments; fruit entirely inclosed; at length freed by the formation of one or more pores.

About 35 species, widely distributed, especially in warm and temperate seas.

Gymnogongrus griffithsiæ (Turner) Martins. Pl. XCV, fig. 3.

Fucus griffithsiæ, Turner, 1808, pl. 37.
Gymnogongrus griffithsiæ, Martins, 1833, p. 27.
Gymnogongrus griffithsiæ, De Toni, 1897, p. 242.
P. B.-A. No. 239.

Frond terete or slightly compressed, 1 to 5 cm. tall, slender, about 1 mm. in diameter, several stems arising from a rootlike callus, branching dense or sparse, usually regularly dichotomous, often polychotomous and with irregular pinnate branches, main branches unbranched below, richly branched above, forming dense tufts at the apices; substance cartilaginous, color dark purple, becoming blackish when dry.

North Atlantic and Pacific Oceans; Mediterranean Sea.

Abundant on Fort Macon jetties, Beaufort, N. C., about 15 cm. above to 15 cm. below low water, throughout the year; occasional on Bogue Beach and in harbor.

Specimens from different localities vary in height and diameter of fronds, amount of branching, and amount of flattening. Those from this region are fairly uniform, being 2.5 to 3.5 cm. tall, and comparatively thick, rigid, and terete.

Genus 2. **Actinococcus** Kuetzing.

Actinococcus, Kuetzing, 1843, p. 177.

Thallus parasitic, minute, living within the tissues of other Florideæ, and forming fruiting cushions on the surface of the host plant; vegetative portion consisting of filaments penetrating the host and winding about among the cells of the frond; fruiting cushions more or less hemispherical or flattened-convex, strongly attached to the host, composed of fanlike radiating filaments, with cells gradually decreasing in size toward the periphery; tetrasporangia numerous in the cortical layer of the nematheciform cushion, moniliform serrate, cruciately divided, arising from the transformation of the cells (usually with the exception of the 2 to 4 apical ones) of the radiating filaments; antheridia and cystocarps unknown.

Four to five species recognized, occurring on different genera of algæ, mostly on species of Gymnogongrus.

The members of this genus were originally taken for the tetrasporic fruits of their hosts. "Several genera of this character have been described. It is a curious fact that in each case the parasite has tetrasporic fruit of the character appropriate to the host, while the host appears to have lost the capacity for producing tetraspores, and is propagated either by cystocarps or only vegetatively." (Collins, 1901a, p. 134.)

Antheridia and cystocarps have been described for one species of Actinococcus, but this observation seems founded on insufficient evidence.

Actinococcus aggregatus Schmitz.

Actinococcus aggregatus, Schmitz, 1893, p. 385, pl. 7, f. 8.
Actinococcus aggregatus, De Toni, 1897, p. 259.
P. B.-A. No. 786.

Parasitic on *Gymnogongrus griffithsiæ*, the vegetative portion occurring as fine filaments between the cells of the host; fruit appearing as a protuberant pad on the surface of the host, minute, about 1 mm. wide, rounded, flattened convex, single or several approximate; tetrasporangia cruciately divided, often imperfectly septate.

North Atlantic and Pacific; Mediterranean Sea.

On about one-fourth of the specimens of *Gymnogongrus griffithsiæ*, Fort Macon jetties, Beaufort N. C.

Family 2. RHODOPHYLLIDACEÆ Schmitz.

Frond terete, flattened, or foliaceous, dichotomously or laterally branched; structure cellular or cellular-filamentous, seldom filamentous; tetrasporangia usually scattered over the thallus surface, sometimes collected into numerous sori, sunk in the outer cortex, which is often thickened to form nematheciumlike structures, nearly always zonately divided; antheridia usually in patches more or less widely distributed over the surface; carpogonia numerous on the fertile portions of the thallus, sometimes distant from the auxiliary cells and, after fertilization, fusing with one of these by a filament; auxiliary cells usually less numerous than the carpogonia, sometimes not formed until after fertilization; cystocarps scattered over the thallus, often situated at the edges, immersed or more or less prominent, usually provided with a conspicuous pore; gonimoblast suspended from an upper wall of the cystocarpic cavity, divided into several lobes radiating in all directions, forming spores in the apical cells of the filaments and sometimes in the subapical ones also.

About 110 species, all marine, in all parts of the world.

KEY TO GENERA.

a. Auxiliary cell forms on a protuberance bearing filamentous tufts, which radiate in every direction and branch outward fasciculately ..... *b*.
b. Frond terete, radially branched, subtubular above, of cellular-filamentous structure ..... 1. Agardhiella (p. 478).
bb. Frond foliaceous, usually pinnately or furcately divided, with numerous warts or papillæ on the surface and margins ..... 2. Meristotheca (p. 479).
aa. Auxiliary cell extends a thick projection into the cystocarpic cavity and bears at its apex numerous tufts of filaments ..... *c*.
c. Frond terete or slightly flattened, laxly tubular, sometimes caulescent and solid below ..... 3. Rhabdonia (p. 480).
cc. Frond terete or flattened, structure dense, rigid, furnished with short, acute or obtuse, simple or branched papillæ ..... 4. Eucheuma (p. 481).

Genus 1. **Agardhiella** Schmitz.

Agardhiella, Schmitz, 1889, p. 441 (7).

Frond terete, branched on all sides, subtubular and rather lax above, structure cellular-filamentous, medullary filaments reticulately anastomosing, more or less lax, cortex large celled within, very small celled without; tetrasporangia scattered over the surface, zonately divided; auxiliary cells not united with the carpogonia, scattered throughout the frond; cystocarps scattered through the frond, entirely immersed or

slightly prominent, "nucleus" transversely oval or almost spherical, situated in the medullary layer or in the inner lax part of the cortex, unilaterally attached to the outer cortex, inclosed by a dense, subdiscrete filamentous pericarp with a broad cellular center and radiating, tufted, expanded filaments, on which the carpospores are borne singly at the apices, the center of the "nucleus" joined to the pericarp by single radial strands of sterile filaments, communicating with the exterior by an apical pore.

Four to five species on Atlantic and Pacific coasts and in Australian regions.

Agardhiella tenera (J. Agardh) Schmitz. Pl. XCVI.

Gigartina tenera, J. Agardh, 1841, p. 18.
Rhabdonia tenera, J. Agardh, 1851, p. 354.
Solieria chordalis, Harvey, 1853, p. 121, pl. 23a.
Rhabdonia tenera, Farlow, 1882, p. 159, pl. 14, f. 2.
Agardhiella tenera, Schmitz, 1889, p. 441 (7).
Agardhiella tenera, De Toni, 1897, p. 322.
P. B.–A. Nos. 138 (*Rhabdonia tenera*) (?), 333 (*Agardhiella coulteri*) (?), 539, 1396 (?), 2143.

Frond filiform, 4 to 45 cm. tall, 0.5 to 4 mm. in diameter; decompoundly much branched, branches subalternately virgate, usually going out from all sides, sometimes secund, cylindrical, constricted at the base, gradually tapering toward the apex, bearing numerous linear, fusiform branchlets; tetrasporangia scattered through the cortex of unaltered branches zonately divided; cystocarps borne on separate plants immersed in slightly swollen branches, rather prominent on one side; substance when young is very delicate, when older is rather firm; color red to purple.

Warm and temperate Atlantic and Pacific coasts of America.

Abundant in winter and spring, occasional in summer and autumn, 15 to 30 cm. below low water, in harbor and on jetties, Beaufort, N. C., many slender plants dredged from the coral reef, August, 1914 and 1915.

The species varies greatly in habit, some specimens bearing only a few large branches, while others bear many fine small ones. It is not likely to be mistaken for any other species occurring in this region except *Eucheuma gelidium;* from the latter it is distinguished by its more open habit, with longer, more slender branches, and by its more delicate texture. It here reaches its greatest luxuriance from December to June, attaining at that time a height of 30 cm. and fruiting abundantly. Specimens collected during the summer and autumn are often much battered, although an occasional vigorous fruiting plant may be found during this period.

Yendo (1914) has suggested that many American specimens which have been referred to this species should be placed under *Rhabdonia robusta* (Grev.) J. Ag. As the determination of this point would require more study than it has been possible to give the matter, the author has followed current usage in referring all the plants to *A. tenera.* This has seemed more proper in that, while some of the plants [notably those dredged from the coral reef in 1914 and 1915 (Plate XCVI, fig. 2), in which the internal filaments were lacking] differed from others in appearance, none of them seemed to agree entirely with the descriptions of *R. robusta.*

Börgesen (1919, pp. 361–365) has given a good description, with figures, of the development of the cystocarp of this species.

Genus 2. **Meristotheca** Agardh.

Meristotheca, Agardh, in J. Agardh, 1871, p. 36.

Frond flat, more or less richly furcately or pinnately (usually irregularly) divided sometimes proliferous from the margins, usually with numerous warts or papillæ arising from the margins and surface; structure cellular-filamentous, hollow, the cavity traversed by numerous filaments, cortex composed of large, rounded cells within, becoming smaller toward the surface, tetrasporangia scattered over the surface among the superficial cells of the cortex, zonately divided; cystocarps situated in the warts and papillæ or embedded in the thallus, more or less prominent, "nucleus" with a filamentous-cellular center and

peripheral, radial paniculate tufts of filaments bearing carpospores usually singly at their apices, pericarp thick, dense, joined to the center of the "nucleus" by numerous sterile strands of filaments.

About six species, mostly in the Indian Ocean.

Meristotheca duchassaingii Agardh. Figs. 31 and 32; Pl. XCVII.

Meristotheca duchassaingii, Agardh, in J. Agardh, 1871, p. 37.
Meristotheca? duchassaingii, De Toni, 1897, p. 330.
P. B.-A. Nos. 884, 1596.

Frond flat, expanded, thick, gelatinous, usually subpalmately laciniate, sometimes simple, sometimes with marginal proliferations, surface and margins of female plants beset with numerous short, simple, or branched papillæ in which the cystocarps are borne, surface of tetrasporic plants smooth or slightly roughened, but not bearing papillæ; tetrasporangia zonately divided; color deep rose.

Florida; West Indies.

Occasionally abundant after storms, Bogue Beach, Beaufort, N. C., two small plants dredged from coral reef offshore, August, 1915.

This species has been observed here from only August to October, but has been collected at points farther south from February to April and may be expected here during any month. It is not known where the plants thrown up on our shores have grown. No specimens were found on the coral reef off Beaufort in May, 1907, or in August, 1914. It seems probable that these specimens grew on submerged coral reefs offshore from Beaufort or south of this region.

This is the northern known limit of the species and of the genus.

As was noted by Collins (P. B.-A. No. 1596), the tetrasporangia are divided zonately as in other species of the genus, not cruciately, as figured by Agardh.

Genus 3. **Rhabdonia** Harvey.

Rhabdonia, Harvey, in Hooker and Harvey, 1847, p. 408.

Frond rather terete, sometimes slightly flattened, usually branched on all sides, more or less laxly tubular, sometimes caulescent and thick below, medullary region traversed by longitudinal, branched, anastomosing filaments, cortex composed of rounded angular cells becoming smaller toward the surface; tetrasporangia scattered over the frond among the superficial cells of the cortex, zonately divided; carpogonia occurring singly, immersed in the cortical layer, usually numerous on the fruiting portions of the thallus, auxiliary cells less numerous, usually not conspicuous before fertilization, usually situated more or less near to the carpogonia and, after union with a process from a fertilized carpogonium, usually fusing with neighboring cells; gonimoblast developed toward the interior of the thallus, forming tufts of filaments radiating in all directions; cystocarps scattered in the branches, immersed, rather prominent, with tufts of branched, spore-bearing filaments radiating from a large central cell intermixed with sterile filaments, inclosed by a thick filamentous pericarp, communicating with the exterior by a pore; carpospores single or in pairs in the terminal segments of the filaments, often germinating within the cystocarp.

About 15 species, principally in Australian regions.

Rhabdonia ramosissima (Harvey) J. Agardh. Pl. XCVIII, fig. 1.

Chrysymenia ramosissima, Harvey, 1853, p. 190, pl. 30 B.
Rhabdonia ramosissima, J. Agardh, 1876, p. 593.
Rhabdonia ramosissima, De Toni, 1897, p. 363.
P. B.-A. No. 993.

Frond rather compressed, more or less cylindrical above, decompound, usually much branched, 6 to 45 cm. tall, main axis 2 to 15 mm. wide, medullary layer very lax, branches alternate, spreading,

subdistichously arranged, tapering toward base and apex, long and short ones intermixed, branchlets very slender, somewhat spiny; cystocarps immersed in the frond, inconspicuous; color light, rosy red; brownish when dry.

Florida; West Indies.

One specimen August, 1903, one specimen September, 1904, Bogue Beach, Beaufort, N. C.

Specimens vary greatly in the width of the main axis, the amount of flattening, and the amount of branching, the habit may be loose or very dense. The Beaufort specimens are narrower and less branched than the majority of specimens from Florida, but seem quite surely to belong to this species. They are readily distinguished from other species occurring here by their slightly flattened main axis bearing long and short branches without order in two rows from the lateral margins.

This is the northern known limit of the species and of the genus. It seems probable that the specimens found here were brought from Florida by the Gulf Stream, although they may have grown on the coral reefs offshore. The species is entirely American, the type being from Key West, Fla.

Genus 4. **Eucheuma** J. Agardh.

Eucheuma, J. Agardh, 1847, p. 16.

Frond terete or flattened, radially or distichously branched, more or less beset with short, simple or branched, sharp or blunt papillæ; medullary region composed of densely crowded anastomosing filaments, cortex dense, composed of fairly large cells within, becoming smaller toward the surface; tetrasporangia scattered among the superficial cells of the cortex, zonately divided; cystocarps immersed in the cortex, prominent, usually in papillæ, sometimes on the thallus itself, having a large, almost spherical central cell from whose surface arise numerous crowded radiating tufts of richly branched spore-bearing filaments separated by strands of sterile filaments running from the central cell to the dense inclosing pericarp, communicating with the exterior by a pore; carpospores borne singly in the terminal segments of the fertile filaments.

About 15 species, in warm seas, especially in the Indian Ocean.

Eucheuma gelidium J. Agardh. Pl. XCVIII, fig. 2.

Eucheuma gelidium, J. Agardh, 1852, p. 627.
Eucheuma gelidium, De Toni, 1897, p. 372.
P. B.-A. Nos. 541, 2184.

Frond ancipitate compressed, pinnately decompound from the margins, 5 to 13 cm. tall, 3 to 5 mm. wide, bearing numerous short, simple or branched, spinelike papillæ, possessed below of few elongated pinnæ, with smaller tooth-shaped ones interspersed, branched above into a dense corymb; pinnæ distichous, flattened, emitting below abbreviated, little-divided, spine-shaped pinnules, in the upper part longer ones divaricately much branched; substance fleshy-cartilaginous, rather rigid; color dirty reddish.

Florida; West Indies; Barbados.

One battered specimen, Bogue Beach, Beaufort, N. C., August, 1904; several specimens, Fort Macon jetty, Beaufort, N. C., July, 1907; rather abundant on jetties, Ocracoke, N. C., August, 1907.

This species can be distinguished from *Agardhiella tenera*, which it most nearly resembles, by its coarser, firmer texture, its denser branching with development of numerous irregular spinelike branches. In section *E. gelidium* has a denser structure, the central (medullary) layer of anastomosing filaments is more developed, and the cortical layer is thicker and is more distinctly composed of short filaments rather than single cells. The specimens from Ocracoke are often in whole or in part rather fine and slender, but are comparatively rigid. In all the specimens from this region the development of spinelike branches is less marked than is usual, although they agree with this species in other respects.

This is the northern limit of the genus on our coast.

Order 3. **Rhodymeniales** Schmitz.

Rhodymeninæ, De Toni, 1900, p. 387.

Carpogonial filaments and mother cells of the auxiliary cells occurring together in pairs, nearly always united into definite procarps, the auxiliary cells usually cut off only after fertilization. Gonimoblast arising from an auxiliary cell after the fertilized egg has fused with this by means of a short carpogonial process, attached to a basal placenta, cystocarps not completely immersed in the frond.

KEY TO FAMILIES.

a. Gonimoblast somewhat immersed in the thallus, filaments radiating from their point of attachment on a median, thickened placenta within the fruit-bearing cavity, pericarp thick, perforated at the apex ..... *b*.

b. Gonimoblast much branched, densely crowded and confluent, usually hemispherical-convex, carpospores borne at the apices of the branches singly or in chains; tetrasporangia cruciately or zonately divided ..... 1. SPHÆROCOCCACEÆ (p. 482).

bb. Gonimoblast divided into several lobes successively developed, nearly all cells of the lobes forming spores; tetrasporangia nearly always cruciately divided. ..... 2. RHODYMENIACEÆ (p. 487).

aa. Gonimoblast sessile in the thallus, formed within the fruit-bearing cavity, covered by the cortex of the thallus with a perforation at the apex ..... *c*.

c. Procarp situated in the median layer of the thallus, gonimoblast attached to the median thickened placenta, gonimolobes usually indistinctly formed, carpospores borne at the apices of the fertile branches singly or in chains; tetrasporangia triangularly divided ..... 3. DELESSERIACEÆ (p. 493).

aaa. Gonimoblast attached to the thallus by means of a pedicel or broad base, entirely external or somewhat inclosed by the cortex in various ways ..... *d*.

d. Cystocarps attached to the thallus by means of a broad base or a short pedicel, gonimoblast attached by a large fusion, central cell within a pericarp perforated at the apex, carpospores large, single in the apices of the fertile branches, less often in chains; tetrasporangia triangularly divided ..... 4. RHODOMELACEÆ (p. 496).

dd. Cystocarps entirely external or inclosed by the cortex, naked (without pericarp) or more or less loosely enwrapped by their own branches, gonimoblasts single or more often in pairs, usually divided into several lobes, carpospores formed from nearly every cell of the fertile branches; tetrasporangia triangularly or cruciately divided ..... 5. CERAMIACEÆ (p. 509).

Family 1. SPHÆROCOCCACEÆ (Dumort) Schmitz.

Thallus terete or flattened, dichotomously or laterally branched, structure cellular or cellular filamentous; tetrasporangia situated in the cortical layer, scattered over the surface of the thallus or in nematheciumlike portions, usually zonately, less often cruciately divided; antheridia variously formed; carpogonia usually numerous on the fertile portions of the thallus, apparently closely associated with the cells which, after fertilization, give rise to the auxiliary cells; cystocarps rather prominent, sometimes formed in special branches and then supported by a quasi short stalk, pericarp often thick, usually provided with an apical pore, often joined to the "nucleus" by sterile strands, gonimoblast arising from the base of the fruit, richly branched, densely crowded and confluent, usually hemispherical-convex, forming spores singly or in chains at the apices of the fertile filaments.

About 150 species in warm and temperate seas, especially in Australian regions.

KEY TO GENERA.

Cystocarps not formed in special branches; gonimoblast composed of several coalescent tufts of branches, rather lax, the apices of the branches unequally extended; tetrasporangia cruciately divided.....1. Gracilaria (p. 483).

Cystocarps not formed in special branches; cavity of the sporocarp traversed by a lax net from the threads of which arise numerous glomeruli of spore-bearing filaments; tetrasporangia zonately divided.....2. Hypnea (p. 485).

Genus 1. **Gracilaria** Greville.

Gracilaria, Greville, 1830, p. 121.

Frond terete or flattened, dichotomously or laterally branched, structure densely cellular, inner cells large, outer ones smaller, cortical ones minute, sometimes developed into vertical filaments; tetrasporangia scattered over the surface among the cortical cells, cruciately divided; antheridia scattered over the branches, in small, flask-shaped cavities opening to the exterior by a pore; cystocarps scattered over the thallus, prominent, hemispherical, pericarp thick, usually free (not joined to the "nucleus" by sterile strands), composed of outwardly radiating rows of cells, finally opening by an apical pore; "nucleus" hemispherical-convex, arising from the base of the fruit, bearing filaments of unequal length from its convex surface; carpospores obovate or oblong produced in longer or shorter chains from the apical segments of the filaments.

About 50 species, all marine, generally distributed, many of the species exceedingly varied in habit and distinguished with difficulty.

KEY TO SPECIES.

Frond terete, slender, light to dark red, branching profuse, fairly regular, lateral, in all planes.....1. *G. confervoides* (p. 483).

Frond from flat to slightly flattened or rather terete, coarse, usually purple to dark green, branching sparse, irregular, dichotomous or polychotomous and lateral, more or less in one plane.....2. *G. multipartita* (p. 484).

1. **Gracilaria confervoides** (Linnæus) Greville. Pl. XCIX, fig. 1.

Fucus confervoides, Linnæus, 1753, vol. 2, p. 1629.
Gracilaria confervoides, Greville, 1830, p. 123.
Gracilaria confervoides. Harvey, 1853, p. 108.
Gracilaria confervoides, De Toni, 1900, p. 431.
P. B.-A. Nos. 384, 1041.

Fronds elongated, terete, vaguely laterally branched, flagelliform, 0.5 to 3 mm. diameter, 14 cm. to 1 m. long, branches elongated, subundivided, branchlets subsecund, slightly attenuated at both ends, filiform, more or less numerous; tetrasporangia numerous, immersed among the cortical cells of short filiform branchlets; cystocarps prominent, hemispherical, numerous on all sides of branches and elongated branchlets, substance fleshy-cartilaginous, color light to dark red.

Warm and temperate seas.

Very abundant throughout harbor, Beaufort, N. C., attached to shells, etc., April to November, less abundant on Fort Macon and Shackleford jetties, abundant on Bogue Beach, abundant in North River, few specimens on coral reef offshore May, 1907, and July to August, 1915, fruiting throughout season; abundant in sound, Wrightsville Beach, N. C., attached to shells; abundant on muddy bottom of tidal marsh, James Island, Charleston, S. C.; abundant on muddy bottom in sound, Port Royal, S. C.

The species varies considerably in the size of plants, coarseness of fronds, and amount of branching, varying from coarse, slightly branched forms to fine, slender, much-branched ones. The habit may be dense or open, according as the branching is more or less abundant, but in all the typical forms the branching is fairly regular and the branches are long, terete, and flexuous. Although some of the specimens approach *G. dura* (Ag.) J. Ag. in appearance and structure, they do not seem separable from the other specimens, and all have been referred to *G. confervoides*. The specimens from Charleston and

Port Royal formed tangled, irregularly branched, apparently sterile masses, with their bases embedded in mud. Their appearance was quite different from that of the more regular, typical forms growing under favorable conditions at Beaufort.

This species, after being thoroughly washed and bleached, has been successfully used at Beaufort for the making of jellies in a way similar to the use of the "Irish moss," *Chondrus crispus*, of our northern coast.

2. **Gracilaria multipartita** (Clemente) J. Agardh. Pl. XCIX, fig. 2.

Fucus multipartitus, Clemente, 1807, p. 311.
Gracilaria multipartita, J. Agardh, 1842, p. 151.
Gracilaria multipartita, Harvey, 1853, p. 107.
Gracilaria multipartita, Farlow, 1882, p. 164.
Gracilaria multipartita, De Toni, 1900, p. 447.
P. B.-A. No. 885.

Fronds from flat to slightly flattened or rather terete, irregularly dichotomously or polychotomously and laterally branched, 1 to 10 mm. wide, 6 to 36 cm. long, branches short or long, sometimes almost simple; tetrasporangia immersed among the cortical cells of the upper segments or over the greater part of the frond; cystocarps very prominent, scattered over the greater part of the frond; texture coarse, substance cartilaginous, color rose red to purple to olive green to light green.

American and European shores of temperate North Atlantic.

Abundant on Fort Macon and Shackleford jetties, Beaufort, N. C., throughout the year from low water to 1.3 m. below low water, less abundant attached to shells in harbor, abundant on Bogue Beach, fairly abundant in North River; abundant in Core Sound at Lecklys Island and Davis Island, fruiting throughout year; very abundant, Ocracoke, N. C.; abundant in sound, Wrightsville Beach, N. C.; abundant in bay, New Inlet, Southport, N. C.; fairly abundant on jetty exposed to sea, Norris Island, Charleston, S. C., from top of rocks washed by waves to depth of 15 cm.

Var. angustissima Harvey.

Gracilaria multipartita var. *angustissima*, Harvey, 1853, p. 107.
Gracilaria multipartita var. *angustissima*, Farlow, 1882, p. 164.
P. B.-A. Nos. 240, 634.

Fronds rather slender and terete, slightly flattened, especially at the axils, 0.5 to 3 mm. wide, 8 to 22 cm. tall, branching more or less regularly dichotomous, often irregular, usually palmatifid at the tips.

Extremely abundant rooted in mud in mouth of one creek in sound, Port Royal, S. C.

This species is exceedingly various in habit, size, diameter, amount of flattening, and manner and amount of branching, varying from plants up to 4 mm. wide and 12.5 cm. tall, greatly flattened throughout, to plants 1 to 1.5 mm. wide and 36.5 cm. tall, nearly terete over most of thallus. Some of the specimens closely resemble specimens referred to *G. compressa* (Ag.) Grev. and other species, but all so overlap that it is impossible to separate them into more than one species, and all are accordingly referred to *G. multipartita*. The variety is not separable from the species and many of the Beaufort specimens might properly be called var. *angustissima*. The specimens from Port Royal referred to the variety are slender, 1 mm. in diameter, 10 to 13 cm. tall, fairly regularly dichotomous.

Three specimens (two cystocarpic and one antheridial) collected on Bogue Beach, Beaufort, N. C., August, 1908, several fragments found on the beach at different times, and one specimen dredged from the coral reef offshore May, 1907, differ decidedly in appearance from all other specimens of the species from this region being thinner and more delicate and membranaceous when dry and being rosy pink instead of green or purple, as are the other specimens; they have the appearance of species of Halymenia. The structure of the antheridia and the cystocarps, however, certainly refers them to this genus, and the structure of the frond is like that of undoubted specimens of *G. multipartita*.

Specimens of *G. confervoides* and *G. multipartita* have frequently been wrongly determined by collectors and are confused in herbaria. In this region, however, they are fairly distinct, although *G. multipartita* var. *angustissima* approaches some of the coarser forms of *G. confervoides*. They may be distinguished as follows: *G. confervoides* is terete throughout, branching fairly regular, branches usually long and tapering at each end, substance usually less cartilaginous and habit finer than in other species, color some shade of red. *G. multipartita* is flattened in some of its extent, if mostly terete is flattened in axils, in such cases is often palmately divided at flattened apices of branches, branching irregular, substance more cartilaginous and habit coarser than in other species, color from light green to dark green to dark reddish purple.

On our coast *G. confervoides* is the more southern form, being recorded for only one locality north of Long Island Sound. At Beaufort *G. confervoides* occurs mainly in the harbor and has been found only from April to November; *G. multipartita* occurs mainly on Fort Macon and Shackleford jetties and remains throughout the year.

Genus 2. **Hypnea** Lamouroux.

Hypnea, Lamouroux, 1813, p. 131.

Frond filiform, rather terete, virgately or divaricately, more or less richly branched on all sides, often with numerous short, spinelike branchlets; fertile and sterile specimens often very different in appearance; structure cellular, traversed by a more or less evident segmented central axis, inner cortex dense, composed of larger cells within, smaller ones toward the surface, outer cortex thin, composed of small vertical cells arranged in subsingle series; tetrasporangia scattered, embedded in the thickened outer cortex of slightly swollen ultimate branchlets, zonately divided; cystocarps almost spherical, prominent on ultimate branchlets, pericarp fairly thick, sometimes perforated by an apical pore, sometimes opening only by the separation of cells at the apex, attached to the base of the cystocarpic cavity by a network of filaments, gonimoblast arising from the base of the cystocarpic cavity, much branched, attached here and there to the network of sterile filaments and at these points giving off radiating tufts of short filaments whose end cells form short chains of carpospores; antheridia arising on the surface, forming a row of four spermatia from each spermatangium; tetrasporangia, cystocarps, and antheridia borne on different plants.

About 25 species in temperate and tropical seas.

Some of the species are easily distinguished, but some are separated by slight (perhaps doubtful) characters and are very difficult to determine. Determination is made still more difficult by the diversity in different forms of the same species, the cystocarpic plants of different species being said in some cases to resemble each other more than do the cystocarpic and tetrasporic plants of the same species. A revision of the genus is needed, and such a study will probably separate the species along different lines from those used at present.

Hypnea musciformis (Wulfen) Lamouroux. Pl. C; Pl. CI, figs. 1 and 2.

Fucus musciformis, Wulfen, 1789, p. 154, pl. 14, f. 2.
Hypnea musciformis, Lamouroux, 1813, p. 131.
Hypnea musciformis, Harvey, 1853, p. 123.
Hypnea musciformis, Farlow, 1882, p. 156.
Hypnea musciformis, De Toni, 1900, p. 472.
P. B.-A. Nos. 196, 2185.

Fronds filiform, 4 to 50 cm. tall, virgately or divaricately, more or less richly branched, branches long, virgate, and rather sparingly clothed with small subulate branchlets, or short, bearing numerous short branches which are densely covered with minute, spinelike branchlets; apices of the branches often thickened and recurved to form tendrils, either naked or bearing short branches on their convex surfaces; tetrasporangia immersed in the thickened outer cortex, scattered over swollen portions at or near the bases of small subulate ultimate branchlets, zonately divided; cystocarps prominent, usually on small spinelike or subulate ultimate branchlets; cystocarpic and tetrasporic plants sometimes differing in habit; color dark green to light reddish green.

Warm and temperate seas.

Very abundant on Fort Macon jetties and in harbor, Beaufort, N. C.; less abundant on Shackleford jetties, attached to rocks, shells, and Zostera, from low water to 60 or 90 cm. below low water, fruiting, May to October, less abundant and usually sterile, November to April; one plant dredged from coral reef offshore, Beaufort, N. C., August, 1915; abundant in Newport River near Green Rock, in North

River, and in Core Sound at Davis Island and Lennoxville. Very abundant at Ocracoke, N. C., on rocks, shells, and Zostera from low water to 60 cm. below low water. Abundant in sound near inlet, Wrightsville Beach, N. C., on shells 15 to 45 cm. below low water. Few plants about 2 cm. tall in sound near inlet, Pawleys Island, near Georgetown, S. C.

The species varies greatly in appearance. Three types connected by numerous intermediate forms may be distinguished. The first (Pl. C, fig. 1) has an elongated, slender, open habit; the principal branches are not very closely set and are long and virgate; the subsidiary branches are small and slender and are rather scatteringly arranged on the main axis and the principal branches; the ultimate branchlets are numerous on the main axis and the branches, being short, slender, simple, spinelike processes from a narrow base; the apices of the main branches and of some of the subsidiary branches are often incurved and thickened to form tendrils. The second type (Pl. C, fig. 2) has an elongated, more or less slender habit, varying from rather open to rather dense; the principal branches are more or less closely set, more or less elongated, and more or less virgate; the subsidiary branches are more richly branched, and more closely set on the main axis and principal branches than in the first type, and are often larger; the ultimate branchlets more or less densely clothe the main axis and the branches, being shorter or longer, slender or coarser, simple or branched, spinelike processes from a narrow or wider base; the apices of the branches are usually straight and tapering, but are sometimes slightly incurved. The third type (Pl. CI, fig. 1) has a shorter, rigid, dense habit; the principal branches are closely set, short or slightly elongated, and divaricate; the subsidiary branches are short and coarse and are closely set on the main axis and the principal branches; the ultimate branchlets densely clothe the main axis and the principal branches, being short, coarse, branched, staghornlike processes from a broad base; the apices of the branches are straight and taper only at the very ends.

These types are not sharply defined, and different branches of the same frond may show the characters of two or even of all three types. The statements of previous authors that tetrasporic and cystocarpic plants show constant differences in habit do not hold strictly in the present case. Although the majority of plants of the first type are tetrasporic, and, so far as observed, all the plants of the third type are cystocarpic, the first type includes cystocarpic plants also, and the second type includes both tetrasporic and cystocarpic plants. In many cases the tetrasporic and cystocarpic plants are indistinguishable in appearance.

Although some of the Beaufort plants have characters that are given for *H. armata* (Mert.) J. Ag. and *H. divaricata* Grev., others closely resemble the type of *H. musciformis* and other authentic specimens of this species and are so connected with the extreme variants by intermediate forms that it seems impossible to place the specimens in more than one species.

Of the plants observed from July to October, about 80 per cent were tetrasporic and 20 per cent cystocarpic. Only one antheridial plant has been found. In unfavorable situations and in spring (April 21, 1908) all the fruiting plants observed were tetrasporic. The species winters in this region by means of small, matted, slender specimens 1 to 6.5 cm. tall, with short, fine branches (Pl. CI, fig. 2). All such specimens observed, with the exception of some collected April, 1908, were sterile. During the season 1908–9 all specimens observed as late as October 17 had their usual summer size and appearance; those collected November 18 were all in the winter condition as described above; this condition was maintained through the collection of April 15; but on May 14 the species was abundant, with all the plants in the summer condition, many being as tall as 22 cm.

The incurved tips function in a way similar to the tendrils of flowering plants, clasping any small support which they may find, firmly attaching themselves by outgrowths from the surface of contact, and sometimes penetrating within the supporting body. In one case a plant of this species was observed with its tendrils so closely wrapped about a stem of *Leptogorgia virgulata* that they had formed constrictions in the hydroid, the ends of many tendrils were embedded in the Leptogorgia, and some of them bore branches within its body. Since this Leptogorgia does not continue to increase in diameter, it would seem that this was due to the active constriction and penetration of the algal tendrils. The rapidity with which this alga may make active attachments is indicated by the fact that when plants were placed in a jar of sea water with oyster shells they had attached themselves to the shells within 24 hours by the tips of several branches. Similar cases have been observed under natural conditions, some branches bending over and attaching themselves by their tips to the substratum.

Family 2. RHODYMENIACEÆ (Nægeli) Harvey.

Thallus terete, compressed or flat, solid or hollow, or with inflated portions, usually erect, less often horizontally expanded, usually furcately or laterally branched, sometimes variously proliferate or lobate, structure usually cellular; tetrasporangia embedded in the outer cortex, scattered over the surface or confined to nematheciumlike, thickened portions, usually cruciately, more rarely triangularly or zonately divided; antheridia variously formed; carpogonia closely associated with cells which, after fertilization, form the auxiliary cells; cystocarps rather prominent, pericarp thick, usually opening by an apical pore, free or joined to the basal placenta by filamentous strands, gonimoblast more or less compact, divided into several lobes formed simultaneously or successively and arising from a large stalk cell situated in the middle of the placenta, forming carpospores from nearly all the cells.

Nearly 200 species, in nearly all seas, especially in warmer regions, but some in Arctic waters.

KEY TO GENERA

a. Frond solid, erect, flattened ..... *b*.
b. Tetrasporangia situated in definite swollen regions of the thallus ..... 1. Rhodymenia (p. 487).
bb. Tetrasporangia borne in sori scattered over the surface ..... 2. Agardhinula (p. 488).
aa. Frond hollow, tubular, terete or slightly flattened ..... *c*.
c. Tetrasporangia cruciately divided; frond hollow in certain regions or throughout ..... 3. Chrysymenia (p. 489).
cc. Tetrasporangia triangularly divided; frond hollow throughout, segmented by constrictions here and there, sometimes with transverse diaphragms ..... *d*.
d. Frond hollow throughout, lacking transverse diaphragms ..... 4. Lomentaria (p. 491).
dd. Frond hollow, but segmented by transverse diaphragm at the constrictions; pericarp with apical pore ..... 5. Champia (p. 492).

Genus 1. Rhodymenia Greville.

Rhodymenia, Greville, 1830, pp. XLVIII, 84.

Frond flat, dichotomously or palmately divided, often with prolierations from the margins, usually stalked below; structure cellular, central axis lacking, medullary cells fairly large, oblong, crowded, cortical cells minute, vertically subradiate; tetrasporangia usually confined to definite regions of the thallus, which are sometimes swollen like nemathecia, embedded among the cortical cells, cruciately divided; antheridia forming superficial sori consisting of single layers of minute, hyaline, vertical cells; cystocarps scattered over the frond, hemispherical, opening by an apical pore, fruiting cavity not filled by a filamentous network, gonimoblast inconspicuously lobate, arising from the base of the cavity, the young lobes composed of segmented filaments, the mature ones having many rotund carpospores irregularly grouped in masses, somewhat inclosed by a gelatinous covering.

About 20 species, widely distributed.

Rhodymenia palmetta (Esper) Greville. Pl. CI, figs. 3 and 4.

Fucus palmetta, Esper, 1797, p. 84, pl. 40.
Rhodymenia palmetta, Greville, 1830, p. 88, pl. 12.
Rhodymenia palmetta, De Toni, 1900, p. 514.

Frond flat, decompound-dichotomous, 1 to 20 mm. wide, 2.5 to 18 cm. tall, cuneate at the base, flabellately expanded above, often supported by a cartilaginous stipe 0.3 to 0.7 mm. wide, 1 to 35 mm. long, gradually passing into the widened frond, segments linear, margins smooth, apices acuminate or rotund; tetrasporangia forming single, rounded sori in slightly swollen portions of the frond below the

apices of the segments, embedded in the scarcely altered cortical layer; cystocarps rather prominent, hemispherical, sessile, on the margins or surface of the terminal segments; texture membranaceous or slightly fleshy; color light to dark rose.

Temperate North Atlantic; Mediterranean.

Occasional on Bogue Beach, Beaufort, N. C., April to September, sometimes fruiting, occasional on Fort Macon jetties about low water level, May to August since 1906, few plants on coral reef offshore, May, 1907, and August, 1915.

The habit of this species ranges from tall, slender, little-branched forms to short, wide, compact, much-branched ones; the texture varies from thin, membranaceous to rather thick fleshy; the widened frond may arise almost directly from the base or may be borne on a more or less elongated stipe. Sometimes the older portions of the frond are membranaceous, while the younger apices are fleshy.

At Beaufort the plants growing on the jetties were compact, fleshy, and much branched, while many of those from the beach were membranaceous and sparingly branched. Plants were not observed growing in the harbor before 1906. This is the northern known limit of the species on our coast.

Genus 2. **Agardhinula** De Toni.

Agardhinula, De Toni, 1897a, p. 64.

Frond flat, dichotomously branched, structure cellular, the medullary portion composed of several series of large, rounded cells, with smaller cells toward the periphery and in the spaces between the larger ones, the cortical portion composed of 1 to 3 layers of small cells, sometimes arranged in vertical rows; tetrasporangia borne in sori scattered over the surface, immersed in the thicker portions of the cortical layer, cruciately divided; cystocarps prominent, scattered over the frond, hemispherical, opening by an apical pore, gonimoblast attached by a few filaments to the flat base of the fruiting cavity, forming a compact, rounded mass of carpospores, very loosely inclosed by branching filaments running from the wall of the cystocarp.

One species.

The structure of the frond in this genus is between that of Rhodymenia and Chrysymenia, more nearly resembling the latter.

Agardhinula browneæ (J. Agardh) De Toni. Fig. 33; Pl. CII, fig. 1.

Callophyllis browneæ, J. Agardh, 1884, p. 36.
Diplocystis browneæ, J. Agardh, 1896, p. 94.
Agardhinula browneæ, De Toni, 1897a, p. 64.
Agardhinula browneæ, De Toni, 1900, p. 523.

Frond flat, decompound-dichotomous or somewhat palmate, sometimes proliferous from the slightly thickened margin, 10 to 30 cm. or more tall, 1 to 5.5 cm. wide, rather thick, tapering below to a cuneate base, segments spreading above rounded sinuses, lower ones wide, upper ones narrower, linear below, dilated above, apices truncate or oblong-obtuse; tetrasporangia in more or less confluent sori covering most of the surface and separated by sterile areas; cystocarps very prominent, densely scattered over the frond, less abundant toward apices; texture cartilaginous-gelatinous; color light pink.

Florida.

One cystocarpic plant, Bogue Beach, Beaufort, N. C., August, 1903; several plants cystocarpic and tetrasporic, Bogue Beach, September 2, 1903.

This species has not been previously recorded since its original discovery on the shore of Florida. The Beaufort plants have been carefully compared with a photograph and a fragment of the type; with this they agree in all respects, notably in the structure of the frond and the cystocarp, so that the determination seems reasonably sure. Since this species has been found at Beaufort only on the two days mentioned above, it seems probable that these plants did not grow in this region, but were brought here by the Gulf Stream from some remote southern locality.

Genus 3. **Chrysymenia** J. Agardh.

Chrysymenia, J. Agardh, 1842, p. 105.

Frond terete or somewhat flattened, hollow in parts or throughout the entire length, sometimes segmented by constrictions, variously branched, sometimes caulescent and almost solid below with hollow, vesicular, bladderlike lateral branches above; filled with loose jelly; structure cellular, central axis lacking, inner cells large, outer ones smaller, cortical ones minute, scattered filaments sometimes traversing the internal tube; tetrasporangia scattered over the thallus surface, embedded among the cortical cells, cru-

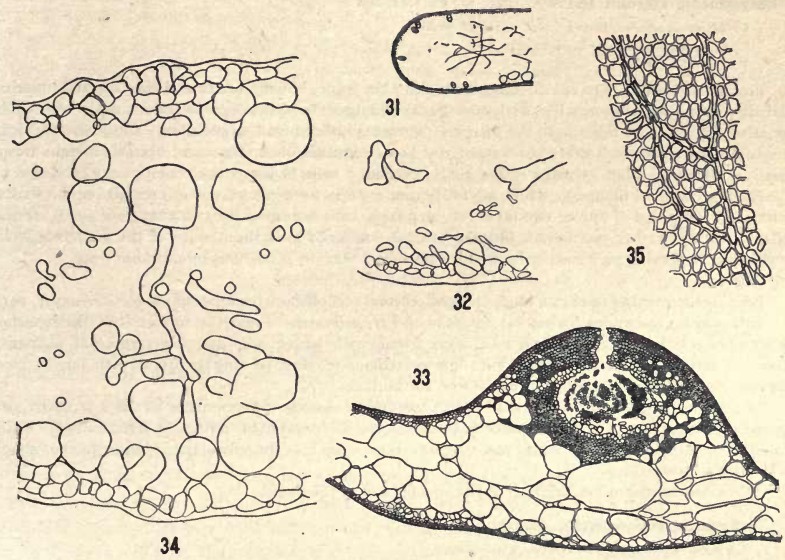


Fig. 31.—*Meristotheca duchassaingii*, showing tetrasporangia and internal structure (diagrammatic) × 30.

Fig. 32.—*Meristotheca duchassaingii*, showing internal structure and tetrasporangium, × 183.

Fig. 33.—*Agardhinula browneæ*, structure of thallus and cystocarp, × 30.

Fig. 34.—*Chrysymenia agardhii*, cross section of thallus, × 183.

Fig. 35.—*Nitophyllum medium* (type), surface view showing veins and cells, × 33.

ciately divided; cystocarps scattered over the frond, fairly conspicuous, hemispherical, opening by an apical pore, fruiting cavity with a trace of a filamentous network or entirely lacking this, gonimoblast arising from the base of the cavity, composed of several coalescent lobes, bearing many rotund carpospores irregularly grouped in masses, somewhat inclosed by a gelatinous covering.

Fifteen to twenty species in warm seas. Some of the species of this genus resemble in external appearance species of Halymenia, from which they may usually be distinguished by their structure. In the species of Chrysymenia the frond is hollow or nearly so, the wall consisting of one or two loose layers of large cells surrounded by one or two layers of small cortical cells; there are usually no filaments traversing the cavity. In

Halymenia the thallus wall is denser, being composed of smaller, more closely crowded cells, and the cavity is traversed by numerous more or less densely crowded filaments.

KEY TO SPECIES.

Frond flat, leaflike..... 1. *C. agardhii* (p. 490).
Frond hollow-tubular and gelatinous-membranaceous throughout; laterally decompound ..... 2. *C. enteromorpha* (p. 490).
Frond caulescent, solid and rigid below, dichotomously branched, bearing numerous hollow, gelatinous-membranaceous, obovate, bladderlike lateral branches below the apices ..... 3. *C. uvaria* (p. 491).

1. **Chrysymenia agardhii** Harvey. Fig. 34; Pl. CII, fig. 2.

Chrysymenia agardhii, Harvey, 1853, p. 189, pl. 30 A.
Chrysymenia agardhii, De Toni, 1900, p. 538.
P. B.-A. No. 746.

Frond flat, leaflike, 5 to 20 cm. long, about 2 to 5 cm. wide, broadly cuneate at the base and tapering gradually into a rather short stipe, dichotomous or subpalmately laciniate, sometimes simple, sometimes irregularly pinnate by lobes from the margins; segments rather broad, approximate above narrow axils, marginal ones somewhat attenuate toward the base, terminal ones attenuate, obtuse; margin wavy, usually eroso-denticulate; thallus rather thick, bearing a more or less conspicuous cavity traversed by branched, segmented filaments, which are fairly numerous in some places, sometimes joining the thallus walls, wall composed of one or two layers of very large cells bordered by 1 to 3 layers of small cortical cells; cystocarps rather prominent, bluntly conical, scattered over the surface of the segments; color bright rose, becoming pale rose or brownish when dry; texture gelatinous-membranaceous.

Florida.

Four sterile plants 7 to 18 cm. long, dredged on coral reef offshore from Beaufort, N. C., August, 1914.

This species resembles *Halymenia floridana* and *H. gelinaria*. From the former it is distinguished by its more gelatinous texture and its thicker frond, with larger cells and fewer internal filaments. From the latter it is distinguished by its less gelatinous texture, its thicker frond with larger, more numerous cells, and the absence of papillæ on the surface.

In none of the specimens has there been observed as abundant filaments or as thick a cortex as is figured by Harvey, and the cortical cells have not been observed in vertically seriate rows. Thick sections, however, especially under low magnification, may give an appearance similar to that shown in Harvey's illustrations.

This is the northern known limit of the species and of the genus.

2. **Chrysymenia enteromorpha** Harvey. Pl. CIII.

Chrysymenia enteromorpha, Harvey, 1853, p. 187.
Chrysymenia enteromorpha, De Toni, 1900, p. 545.
P. B.-A. No. 386.

Frond tubular-hollow, terete or flattened, about 5 to 30 cm. tall, 4 to 8 mm. in diameter, arising from a slightly tapering base, laterally decompound branches elongated, similar to the main axis, constricted at their bases, apices obtuse, often narrowed below the apex and terminated by an obtuse apiculum; main branches flattened or terete, ultimate branches and branchlets terete; thallus wall consisting of one or, more rarely, two loose layers of large cells bounded by a single layer of minute cortical cells; cavity of frond filled with soft jelly; tetrasporangia inconspicuous, scattered over the surface without order among the cortical cells, cruciately divided; cystocarps small, not very prominent, scattered over the branches; texture delicate gelatinous-membranaceous; color light yellowish to rosy pink.

Florida and West Indies.

Two specimens, one tetrasporic, the other cystocarpic, Bogue Beach, Beaufort, N. C., August, 1907, one specimen dredged from coral reef offshore, August, 1914.

The specimens from Bogue Beach (Pl. CIII, fig. 1) and the one from the coral reef (Pl. CIII, fig. 2) differ greatly in appearance, although both seem to come within the range of the species.

The doubt expressed by De Toni (l. c.) concerning the placing of this species in this genus apparently based on the lack of knowledge concerning the method of division of the tetrasporangia, seems removed by the observation of the author that these divide cruciately, as is characteristic for the genus.

This is the northern known limit of the species and of the genus.

3. Chrysymenia uvaria (Linnæus) J. Agardh. **Pl. CIV, fig. 1.**

Fucus ovarius, Linnæus, 1765, Tom. 3, p. 714.
Chrysymenia uvaria, J. Agardh, 1842, p. 106.
Chrysymenia uvaria, Harvey, 1853, p. 191, pl. 20 B.
Chrysymenia uvaria, De Toni, 1900, p. 543.
A. A. B. Ex. No. 150.
P. B.-A. Nos. 289, 1933.

Frond 2.5 to 22 cm. tall, consisting of a solid, terete, rigid, dichotomous, stemlike portion 0.5 to 1 mm. in diameter, naked below, bearing numerous small, hollow, obovate, bladderlike lateral branches on short stalks above; several fronds arising from a common disklike attachment; tetrasporangia and cystocarps borne on the vesicular lateral branches; tetrasporangia immersed in the cortical layer, triangularly divided; cystocarps not abundant in any branch, not very prominent; texture of stemlike portion cartilaginous, of the vesicular lateral branches gelatinous-membranaceous; color rose.

Florida; West Indies; Bermuda; Canary Islands; Mediterranean and adjoining regions; Hawaii.

Occasional on Bogue Beach, Beaufort, N. C., summer and autumn, fairly abundant on coral reef offshore May, 1907, August, 1914, and July to August, 1915.

This is the northern known limit of the species and of the genus on our coast.

Genus 4. **Lomentaria** Lyngbye.

Lomentaria, Lyngbye, 1819, p. 101.
Chylocladia, De Toni, 1900, p. 572.

Frond terete or slightly flattened, hollow-tubular throughout, sometimes segmented by constrictions, branching various, mostly lateral; structure cellular, central axis lacking, thallus wall usually rather thin, composed of three layers, a loose layer of elongated branched filaments bordering the internal tube and sometimes scatteringly traversing this, a single middle layer of large cells, and an outer layer composed of more or less numerous small cortical cells; tetrasporangia borne on slightly dilated branchlets, in cavities formed by the depression of the thallus wall, protruding into the internal cavity, scattered or sometimes joined into groups, triangularly divided; antheridia borne at the ends of short, cellular filaments arising from the cortical cells, forming superficial sori; cystocarps scattered over the frond, rather prominent, globose or subconical, opening by an apical pore, fruiting cavity usually lacking a filamentous network or sometimes with a trace of this; gonimoblast arising from the base of the cavity, composed of several successively formed lobes, bearing numerous oblong or obovate carpospores from the outer segments of branched fruiting filaments, at first arranged radiately, at length conglobate without conspicuous order, usually inclosed by a gelatinous covering, pericarp connected to base of the cystocarp by filamentous strands separating the groups of spores.

About 15 species, in warm and temperate seas.

KEY TO SPECIES.

Frond rather terete, branching irregular, often secund, branches slender, often recurved ..... 1. *L. uncinata* (p. 492).
Frond somewhat flattened, branching regular, distichous, branches compact, not recurved ..... 2. *L. rosea* (p. 492).

1. **Lomentaria uncinata** Meneghini. Pl. CIV, fig. 2.

Lomentaria uncinata, Meneghini, in Zanardini, 1840, p. 215 (21).
Chylocladia baileyana, Harvey, 1853, p. 185, pl. 20 C.
Lomentaria uncinata, Farlow, 1882, p. 154.
Chylocladia ? uncinata, De Toni, 1900, p. 574.
A. A. B. Ex. No. 75 (*Lomentaria baileyana*).
P. B.-A. Nos. 886, 1399.

Frond rather terete, 0.1 to 1 mm. in diameter, 1 to 12 cm. tall, hollow throughout, not segmented by constrictions, branching usually fairly profuse, irregular, often secund, branches tapering, often recurved, sometimes becoming attached by their apices, branchlets fusiform, constricted at the base, tapering at apex, and irregularly borne; tetrasporangia in slightly thickened branchlets; antheridia usually occurring on separate plants, usually borne at the apices of branches, in enlarged, spherical heads composed of short, radiating, club-shaped, 2 to 4 celled filaments arising from the cortical cells and bearing the antheridia at their apices; cystocarps ovoid, sessile on the branchlets; texture gelatinous-membranaceous; color dull rose, sometimes yellowish or greenish.

New England to Florida and West Indies; Mediterranean.

Fairly abundant along town front and on Fort Macon jetties, Beaufort, N. C., April, 1908, occasional on other algæ and on Ascidian, *Styela plicata*, in harbor, summer and autumn, fairly abundant on sea buoy, September, 1905. One small mass on buoy in sound, Port Royal, S. C., August, 1909.

This species is most easily recognized by its recurved branches, which may bend down and become attached at the apices. Such branches may give off other branches from their convex sides, some of which may in turn bend down and become attached, the continuation of this process giving rise to an appearance like a series of arches. The plants of this species growing in the harbor at Beaufort in April, 1908, were well developed, being 2 to 4 cm. tall; those found during the summer and autumn are minute, scarcely recognizable forms 1 cm. or less in height.

2. **Lomentaria roses** (Harvey) Thuret. Pl. CIV, fig. 3.

Chylocladia rosea, Harvey, 1853, p. 186.
Lomentaria rosea, Thuret in Le Jolis, 1863, p. 131.
Lomentaria rosea, Farlow, 1882, p. 155.
Chylocladia rosea, De Toni, 1900, p. 575.
A. A. B. Ex. No. 17.
P. B.-A. No. 1241.

Frond somewhat flattened, 1 to 4.5 mm. wide, 2 to 7.5 cm. tall, hollow throughout, not segmented by constrictions, branching usually profuse, branches straight, tapering, bearing numerous distichous, opposite or alternate simple, or pinnate branchlets, which are lanceolate-oblong above a markedly constricted base; tetrasporangia in the branchlets; cystocarps unknown; texture gelatinous-membranaceous; color bright rose.

North Atlantic shores of America and Europe.

One well-developed specimen on coral reef offshore, Beaufort, N. C., May, 1907.

This species is readily distinguished from the preceding one by its flattened frond, with denser habit, the branches not recurved at the apices, the branchlets being numerous, distichous, regularly opposite or alternate, and greatly contracted at the bases. It is distinguished from *Champia parvula*, which it somewhat resembles, by the lack of constrictions and transverse diaphragms segmenting the frond.

This is the southern known limit of the species.

Genus 5. **Champia** Desvaux.

Champia, Desvaux, 1808, p. 245.

Frond terete or slightly flattened, hollow-tubular, but septate by thin, cellular, transverse diaphragms occurring at more or less conspicuously constricted nodes, branching various; structure cellular, central axis lacking, thallus wall thin, composed of more or less of three layers (a loose layer of elongated filaments bordering the internal tube and sometimes scatteringly traversing this, connecting the diaphragms, a middle layer of larger cells, and an outer layer of more or less numerous smaller cortical cells), often

composed of a single layer of large cells; tetrasporangia scattered over the surface of branches and branchlets among the cortical cells, triangularly divided; antheridia usually on separate plants, borne singly on the tips of short filaments which arise in branching clusters from the thallus cells; cystocarps scattered over the frond, ovate, opening by a conspicuous apical pore, arising from the base of the cavity, surrounded by a filamentous network, composed of several simultaneously or successively formed lobes, bearing numerous oblong or obovate carpospores from the outer segments of branched fruiting filaments, conglobate without conspicuous order, inclosed by a gelatinous covering.

About 12 species, in warm and temperate seas.

Champia parvula (Agardh) Harvey. Pl. CIV, fig. 4.

Chondria parvula, Agardh, 1824, p. 207.
Champia parvula, Harvey, 1853, p. 76.
Champia parvula, Farlow, 1882, p. 156, pl. 15, f. 2, 5.
Champia parvula, De Toni, 1900, p. 558.
P. B.-A. Nos. 290, 592, 1934.

Frond slightly flattened, 0.5 to 1.5 mm. wide, 2 to 10 cm. high, branching profuse, often intricate with coalescent branches below, branchlets arising alternately, oppositely, or verticillately, patent, apices tapering slightly, obtuse, bases sometimes slightly constricted, segments of the frond barrel shaped, once or twice as long as broad; tetrasporangia scattered over the branches and branchlets; antheridia forming patches indefinite in extent, occurring sometimes as caps at the ends of branches, usually as bands around older portions of the thallus; cystocarps ovate, scattered, sessile on the branches; texture gelatinous-membranaceous; color light to dark pink, sometimes purplish or greenish.

Warm and temperate North Atlantic; Mediterranean.

Fairly abundant throughout harbor, on Fort Macon and Shackleford jetties, and on Bogue Beach, Beaufort, N. C., April, 1908, fairly abundant on coral reef offshore, May, 1907, and July to August, 1915, occasional in harbor, on jetties, and on buoys during summer and autumn. Rather scarce in sound near inlet, Wrightsville Beach, N. C., July, 1909.

This species may be distinguished easily by its hollow-tubular structure septate by transverse diaphragms at more or less evidently constricted nodes.

Family 3. DELESSERIACEÆ (Nægeli) Schmitz.

Thallus flat, very rarely filiform, sometimes perforate or reticulately fenestrate, simple or forked or lobed or proliferous in various ways, structure cellular, sometimes provided with midrib and veins; tetrasporangia triangularly divided, usually occurring in sori embedded in the locally thickened cortex, scattered over the thallus or occurring on special portions, usually regularly arranged and occurring on both sides of the thallus; antheridia, where known, occurring in small, roundish sori scattered over the surface, usually on both sides of the thallus, the antheridia being cut off directly from thallus cells and giving rise, by successive division, to several spermatia; carpogonia closely associated with cells which function as auxiliary cells; cystocarps rather prominent, sessile, scattered over the frond or occurring on special portions, opening by an apical pore, pericarp usually free from the small basal placenta, sometimes joined to this here and there by remnants of the filamentous network, gonimoblast more or less compact, composed of tufts of branched filaments, which arise from a large, basal stalk cell, are developed simultaneously or successively, are loose or compact, sometimes being grouped into lobes, and bear carpospores singly or in short chains or groups from their apices.

Nearly 200 species, in nearly all seas, principally in warmer, especially Australian, regions.

KEY TO GENERA.

Frond usually dichotomously or pinnately branched, midrib inconspicuous or lacking, veins, when present, usually forming a network over the thallus.....1. Nitophyllum (p. 494).

Frond usually simple, sometimes irregularly branched, midrib conspicuous below, veins usually not visible to naked eye, arising pinnately from the midrib.....2. Grinnellia (p. 495).

Genus 1. **Nitophyllum** Greville.

Nitophyllum, Greville, 1830, p. 77.

Thallus flat, thin-membranaceous, sessile or borne on a short stalk, simple or dichotomously branched or lobed or divided in various ways, veins present or absent, if present more or less prominent, sometimes elevated, much branched and usually anastomosing, sometimes more prominent, branched, usually anastomosing nerves and occasionally a slight midrib also present; composed of one or a few layers of cells, outer cells large and irregularly angular in surface view, squarish or oblong in section, cells of inner layers sometimes different from the outer ones, veins and nerves composed of several layers of narrow, elongated cells; apical cell evident in the young frond, sometimes persistent for a while, but sooner or later disappearing, the growth of the adult frond being intercalary; tetrasporangia triangularly divided, occurring in sori forming rounded, flattened thickenings prominent on both surfaces of the frond, variously situated in different species; cystocarps scattered over the frond, variously situated, sessile, prominent on both surfaces of the thallus, rounded, slightly flattened, opening by an apical pore, gonimoblast arising from the base of the cavity, composed of radiating, branching, segmented filaments more or less compacted into lobes producing carpospores singly or in short chains from their terminal segments.

About 75 species, in warm and temperate seas.

Nitophyllum medium sp. nov. Fig. 35; Pl. CV; Pl. CXIV, figs. 4 and 5.

Thallus erect, flat, ribbonlike, borne on a (usually short) more or less definite stipe, 5 to 22 cm. tall, 4 to 19 mm. wide, decompound-dichotomously branched, margins usually undulate, often bearing minute proliferations; veins numerous, sometimes conspicuous, sometimes invisible to the naked eye, repeatedly branched, subsingle toward apices, anastomosing frequently throughout most of thallus, coalescent below into stipe; thallus composed of a single layer of cells except at margins and in regions of sori and veins, margins irregularly more or less thickened, sori usually surrounded by more or less extensive regions three cells thick, veins three to five (rarely six) cells thick, usually one (rarely two) cells wide, sometimes bordered by a narrow region of thallus three cells thick; tetrasporangial sori numerous, small, prominent on both surfaces, borne throughout thallus except toward base, forming more or less irregular (often very irregular) parallel or radiating lines, usually between the veins; antheridia and cystocarps unknown; texture thin-membranaceous; color light pink to rose.

Thallo erecto, plano, plus minus definite (plerumque breve) stuposa, 5–22 cm. longo, 4–19 mm. lato, decomposito-dichotome ramoso, marginibus plerumque undulatis, saepe proliferationes minutas ferentibus; venis numerosis, nunc manifestis, nunc oculo nudo invisibilibus, iterum atque iterum ramosis, ad apices subsimplicibus, per maximam partem thalli frequenter anastomosantibus, in inferiore fronde in stipitem coalescentibus; thallo, praeter margines et regiones sororum et venarum, una pagina cellularum composito, marginibus inaequaliter plus minus densis, soris plerumque ab regionibus plus minus latis, 3 cellulis crassis, cinctis, venis 3–5 (rarius 6) cellulis crassis, plerumque 1 (rarius 2) cellulis latis, aliquando ab regione thalli angusta 3 cellulis crassa tactis; soris tetrasporangiorum numerosis, parvis, in superficiebus ambis prominentibus, per thallum, praeter partem inferiorem positis, lineas plus minus irregulares (saepe irregularissimas) parallelas aut radiantes, plerumque inter venas, formantibus; antheridiis et cystocarpiis ignotis; substantia tenue membranacea; colore diluta punicea aut rosea.

Beaufort, N. C.: Occasional on Bogue Beach, February to September, probably throughout the year, often fairly abundant after storms, especially during summer and autumn; several small masses, Fort Macon jetty, July and August, 1906, and one plant September, 1907, 5 to 30 cm. below low tide; few plants on coral reef offshore, 24 to 25.5 m. below surface, May, 1907.

This species seems to belong to the subgenus Cryptoneura J. Ag. In respects other than the arrangement of the sori it closely resembles *N. laceratum* Grev. The structure of these species is so similar that it would seem to indicate a relationship, but the sori are not confined to the margin or marginal proliferations as in *N. laceratum* and other species of the tribe Botryoglossopsis (J. Ag.) De Toni. In many respects *N. medium* resembles species of the tribe Dawsoniæ (Bory) J. Ag. Although the sori are somewhat irregularly arranged and usually are not conspicuously radiating toward the margins, they are not more irregular than in some species of that tribe. The veins are, however, narrower and the margins thicker than in the species under Dawsoniæ which have been available to the author, and the present species does not seem to agree closely with any of the sections under that tribe. If it should be placed under Dawsoniæ, it perhaps agrees best with the section Supradecompositæ J. Ag., although the frond is usually more regularly dichotomous than in species of that section available to the author. Its position in the subgenus must, therefore, be left in doubt pending more extended comparisons.

No specimens have been found by the author except at Beaufort, but several unnamed specimens from points south of this place observed in American herbaria seem to belong to this species. One of these in the herbarium of the New York Botanical Garden is labeled "Delesseria? L. I. G. Pawley's I, July or Aug. 1875." The present known distribution of the species may, therefore, be given as from Beaufort, N. C., to Pawleys Island, near Georgetown, S. C.

The type (Pl. CV, fig. 2) is a tetrasporic plant collected on Bogue Beach, Beaufort, N. C., July 12, 1907. This has a longer stipe than is usually found, but in other respects is a fair average of the species. In other specimens the veins are sometimes more, sometimes less, conspicuous, the sori are sometimes larger and more clustered toward the apices, and sometimes (Pl. CV, fig. 3) more nearly in regular rows, while sometimes the branching is a little more irregular. The type, with several cotypes and other specimens, together with slides used in the study of the species, have been placed in the U. S. National Herbarium.

Genus 2. Grinnellia Harvey.

Grinnellia, Harvey, 1853, p. 91.

Frond flat, thin-membranaceous, borne on a short stalk, usually simple, sometimes irregularly branched, traversed by a midrib which is conspicuous below, becoming less conspicuous near the apex, sometimes with lateral nerves arising pinnately from the midrib barely visible to the naked eye; composed of a single layer of cells over most of the frond, at the midrib of several layers of cells, cells irregularly angular in surface view, squarish or oblong in section; apical cell evident in the young frond, soon disappearing, the growth of the adult frond being intercalary; tetrasporangia triangularly divided occurring in sori forming small, rather indefinite thickenings scattered over the frond; antheridia borne at the ends of short filaments arising in clusters from the thallus cells on both sides of the frond; cystocarps scattered over the frond, sessile, hemispherical, rather prominent, pericarp thin, opening by a conspicuous apical pore, joined to the basal placenta by thin, filamentous, sterile strands, gonimoblast composed of rather loose, dichotomously branched filaments which form carpospores from nearly all their cells.

One species, New England to West Indies.

Grinnellia americana (Agardh) Harvey. Pl. CVI, fig. 1.

Delesseria americana, Agardh, 1820, p. 173.
Grinnellia americana, Harvey, 1853, p. 92, pl. 21 B.
Grinnellia americana, Farlow, 1882, p. 161, pl. 13, f. 2–4.
Grinnellia americana, De Toni, 1900, p. 723.
A. A. B. Ex. Nos. 64a, 64b.
P. B.-A. Nos. 593, Fasc. A, No. XXII.

Frond flat, thin-membranaceous, 1 to 11 cm. wide, 6 to 45 cm. long, usually unbranched, supported on a short stalk continuous with the midrib, tapering at each end; tetrasporangial sori appearing as minute dots scattered over the surface, antheridia as small, whitish spots scattered over the frond, cystocarps as evident dots larger and more conspicuous than the tetrasporangial ones; tetrasporangia, antheridia, and cystocarps borne on different plants; color light to dark rosy pink, sometimes purplish.

New England to West Indies.

Fairly abundant throughout harbor and on jetties, Beaufort, N. C., 10 to 30 cm. below low water, December to May, small specimens occasional on Fort Macon jetties during summer and autumn, small specimens on coral reef offshore, May, 1907, and August, 1914; few specimens 1 cm. tall or less, in sound, Pawleys Island near Georgetown, S. C., August, 1909.

Family 4. RHODOMELACEÆ (Reichenbach) Harvey.

Frond terete or flattened, usually richly laterally or dichotomously branched, erect or horizontal, structure usually radial, sometimes dorsiventral, cellular, sometimes cellular-filamentous, usually with a conspicuously polysiphonous axis composed of a segmented central axis surrounded by one or more circles of large pericentral cells of equal length, sometimes covered by one or more layers of small cortical cells, apical cell segmented transversely or obliquely (in one subfamily, Laurenciæ, approaching the tetrahedral type) the thallus bearing more or less numerous, persistent or evanescent, usually much branched, monosiphonous filamentous lateral outgrowths (trichoblasts); tetrasporangia numerous, arising from pericentral cells, embedded in the thallus, covered by special cover cells, scattered over the unaltered smaller branches or in altered branches (stichidia), triangularly divided; antheridia borne on trichoblasts, sometimes apparently on a polysiphonous branch, occurring as small compact bodies of various forms, oval to long cylindrical, terete or flattened, bearing a layer of spermatangia over all or nearly all the surface; carpogonia situated on trichoblasts, sometimes apparently on a polysiphonous branch, closely associated with cells which, after fertilization, produce the auxiliary cells, forming definite procarps sooner or later inclosed by sterile outgrowths from the thallus; cystocarps external, conspicuous, secondarily situated on polysiphonous branches, sessile or borne on short stalks, oval or urceolate, pericarp thick, opening by an apical pore, gonimoblast arising from the basal placenta, consisting of a compressed, more or less compact tuft of richly branched filaments, whose apical cells usually produce single, large, oval, or club-shaped carpospores, but in one subfamily, Dasyeæ, form small cylindrical carpospores in short chains, the spores, in the former case, having the appearance of arising singly on short stalks from the base.

The largest family of the Rhodophyceæ, containing about 600 species, occurring in all seas, especially in the temperate regions of the Southern Hemisphere.

KEY TO GENERA.

a. Growth of thallus sympodial, structure radial, with five pericentral cells, tetrasporangia not completely embedded in the stichidia, branching radial ..... 7. Dasya (p. 508).
aa. Growth of thallus monopodial ..... *b*.
b. Thallus with dorsiventral structure, creeping, bearing elongated, alternate, lateral, creeping branches at regular intervals, and short, erect branches between these, tetrasporangia occurring singly ..... 6. Herposiphonia (p. 507).
bb. Thallus usually with radial structure, erect throughout or with conspicuous erect branches from an inconspicuous creeping base ..... *c*.
c. Polysiphonous axis not evident, thallus composed of large cells not arranged in circles, apical cell divided somewhat tetrahedrally, tetrasporangia situated without apparent relation to a pericentral cell ..... 1. Laurencia (p. 497).

cc. Polysiphonous axis plainly evident, thallus composed of one or more circles of large cells around a row of central cells, apical cell transversely or obliquely divided, tetrasporangia produced from pericentral cells.....*d.*

d. Thallus with conspicuous erect branches from a creeping base, distichously branched, pericentral cells with secondary transverse divisions.....5. Bostrychia (p. 506).

dd. Thallus erect throughout, radially branched, pericentral cells without secondary transverse divisions.....*e.*

e. Trichoblasts persistent, covering portions of the frond in the form of colored, branched, monosiphonous filaments.....4. Brongniartella (p. 505).

ee. Trichoblasts evanescent, occurring only on the younger portions of the frond.....*f.*

f. Thallus with dense parenchymatous structure, polysiphonous arrangement not conspicuous, covered by a dense cortex, pericarp thick, tetrasporangia occurring singly without conspicuous order in spindle-shaped branchlets markedly constricted at their bases.....2. Chondria (p. 498).

ff. Thallus with rather loose structure, polysiphonous arrangement-conspicuous, naked or covered by a thin cortex, pericarp thin, tetrasporangia usually occurring singly in straight or spiral rows in scarcely altered branchlets.

3. Polysiphonia (p. 502).

Genus 1. **Laurencia** Lamouroux.

Laurencia, Lamouroux, 1813, p. 130.

Frond erect, terete or flattened, richly radially or distichously branched; structure cellular, dense, cells large within, becoming smaller toward the surface, situated without conspicuous order, central row of cells not evident except toward apices, apical cell surrounded by evanescent trichoblasts, sunk in a depression, somewhat tetrahedrally divided, pericentral cells not formed; tetrasporangia scattered over the ultimate, frequently shortened branchlets among the outer subcortical cells, with no apparent relation to pericentral cells, triangularly divided; antheridia oval to oblong, borne on tufts of branched filaments (trichoblasts) arising from the bases of open, scutellate, apical depressions; procarps borne on trichoblasts within the apical depressions, coming secondarily to lie on the surface as a result of later growth, cystocarps scattered over the smaller branches, prominent, ovate to spherical, pericarp thick, opening by an apical pore, gonimoblast composed of branched filaments radiating from a basal placenta, bearing single pear-shaped carpospores in their terminal segments.

About 50 species, often with ill-defined limits and exceedingly difficult to determine, in warm seas.

Laurencia tuberculosa J. Agardh.

Laurencia tuberculosa, J. Agardh, 1852, p. 760.
Laurencia tuberculosa, Harvey, 1853, p. 75.
Laurencia gemmifera var. *β*, Harvey, 1853, p. 73.
Laurencia tuberculosa, De Toni, 1903, p. 801.
A. A. B. Ex. No. 62.
P. B.-A. Nos. 439, 1937.

Frond subterete or slightly flattened, about 1 to 2 mm. wide, 5 to 20 cm. tall, branching alternate subdistichous, pinnately decompound, branches spreading, bearing numerous short, simple, blunt, wart-like tubercular branchlets distichously arranged below, naked toward the apices; tetrasporangia in the short, tubercular branchlets; texture rather cartilaginous; color crimson to fleshy purple.

Florida and West Indies.

Var. **gemmifera** (Harvey) J. Agardh. Pl. CVI, fig. 2.

Laurencia gemmifera, Harvey, 1853, p. 73, pl. 18 B.
Laurencia tuberculosa var. *gemmifera*, J. Agardh, 1876, p. 657.
Laurencia tuberculosa var. *gemmifera*, De Toni, 1903, p. 802.
P. B.-A. No. 141.

Frond terete, branching profuse, alternate, irregular, decompound, forming more or less intricate tufts, branches spreading, bearing numerous short, simple, blunt, tubercular branchlets on all sides, longer and shorter branches intermingled without order; texture cartilaginous and brittle; color light red or yellowish, sometimes greenish.

Florida and West Indies.

Abundant on Bogue Beach and floating in harbor, Beaufort, N. C., August to October, 1905 (few plants tetrasporic), few small masses unattached on bottom near "Green Rock" in Newport River, August, 1906, occasional on Bogue Beach, September, 1906, one large plant (male) on Shackleford jetty about 30 cm. below low water, August, 1907.

The specimens from this locality do not resemble authentic specimens of *L. tuberculosa*, but closely resemble a specimen from Key West labeled "*L. gemmifera*" by Harvey. In herbaria the variety passes over into the species, but in this region the plants are quite uniform, with little variation, and are always light to dark green. They will not be mistaken for any other species occurring at Beaufort, being easily distinguished by the richly and irregularly branched, intricate tufts of stiff, brittle, cartilaginous, dull green fronds bearing numerous short, blunt, tubercular branchlets on all sides.

This is the northern known limit of the species and of the genus.

Besides the above species, there were collected on Bogue Beach in August, 1906, several battered specimens evidently belonging to another species of Laurencia. These somewhat resemble a battered specimen of *L. pinnatifida* (Gmel.) Lamour., but are indeterminable.

Genus 2. **Chondria** (Agardh) Harvey.

Chondria, Agardh, 1817, p. XVIII.
Chondria, Harvey, 1853, p. 19.
Chondriopsis, Farlow, 1882, p. 165.

Frond erect, terete or somewhat flattened, richly branched, branches arising radially or pinnately, usually alternately, virgate, bearing branchlets which are markedly constricted at their bases; structure cellular, with a single circle of five loose pericentral cells surrounded by several layers of smaller cells within the surface and one or more layers of small cortical cells, growing points prolonged or sunk in slight apical depressions, apical cell transversely divided, trichoblasts somewhat persistent, but finally evanescent; tetrasporangia usually numerous, occurring without conspicuous order among the subcortical cells toward the middle or upper parts of spindle-shaped ultimate branchlets, formed from segments of the pericentral cells, triangularly divided; antheridia irregularly oval, sometimes crumpled plates attached by short stalks to trichoblasts on ultimate branchlets, bordered by one or more rows of sterile cells (fig. 39); cystcarps numerous, sessile on the ultimate branchlets, prominent, ovate, pericarp thick, opening by an apical pore, gonimoblast composed of branched filaments radiating from a basal placenta, bearing single large, elongated, pear-shaped carpospores in their terminal segments; tetrasporangia, antheridia, and cystocarps borne on separate plants

About 25 species, often separated by variable characters and exceedingly difficult to determine, in warm and temperate seas.

KEY TO SPECIES.

a. Apices of branches prolonged ..... *b*.
b. Fronds delicate, slender ..... 3. *C. tenuissima* (p. 500).
bb. Fronds coarse, robust, densely branched ..... 1. *C. atropurpurea* (p. 499).
bbb. Fronds coarse, robust, loosely branched ..... 2. *C. littoralis* (p. 499).
aa. Apices of branches forming crateriform depressions ..... *c*.
c. Fronds coarse, rigid, brittle, branching sparse below, often dense above, color dark reddish purple ..... 4. *C. dasyphylla* (p. 500).
cc. Fronds of moderate coarseness, flexuous, branching uniformly profuse, color pinkish straw ..... 5. *C. sedifolia* (p. 501).

1. **Chondria atropurpurea** Harvey.

Chondria atropurpurea, Harvey, 1853, p. 22, pl. 18 E.
Chondria atropurpurea, De Toni, 1903, p. 831.

Fronds robust, rather coarse, 5 to 26 cm. tall, 0.7 to 2 mm. in diameter in main stems, rather pyramidal in outline, densely, irregularly, alternately branched, main branches elongated, spreading, sometimes virgate, sparingly beset with secondary branches and branchlets, longer and shorter branches interspersed without order, the ultimate branchlets and usually the secondary branches tapering at each end, having the apices prolonged and being markedly constricted at the base, branchlets arising singly or somewhat fasciculately from superficial depressions, spindle-shaped; tetrasporangia in the ultimate branchlets; cystocarps broad-ovate, sessile on the ultimate branchlets; texture cartilaginous, firm; color usually dark reddish purple, sometimes lighter and yellowish.

South Carolina to Florida; Brazil; Japan.

One specimen on shell between jetties, Fort Macon, Beaufort, N. C., August, 1906?

To this species is referred with considerable doubt one specimen from Beaufort. The species has not been observed elsewhere by the author, but should be included as it certainly occurs within our range, the type being from Charleston, S. C. The habit is similar to that of *C. dasyphylla*, from which it is distinguished by its prolonged apices and sometimes by its lighter color. The Beaufort specimen does not show the constrictions at the bases of the secondary branches, the marked constrictions at the bases of the branchlets, or the origin of the latter from superficial depressions, as is characteristic of the species; but resembles the species in other respects. If this determination is correct, this is the northern known limit of the species.

2. **Chondria littoralis** Harvey. Figs. 36 and 37; Pl. CVII, fig. 1.

Chondria littoralis, Harvey, 1853, p. 22.
Chondria littoralis, De Toni, 1903, p. 832.

Frond robust, rather slender, 10 to 35 cm. tall, 0.8 to 2 mm. in diameter in main stems, often pyramidal in outline, irregularly or sometimes somewhat dichotomously loosely much branched, main branches elongated, flexuous, tapering, sometimes almost naked and virgate, sometimes more or less densely beset with secondary branches and branchlets, apices more or less prolonged, branchlets about 3 to 25 mm. long, more or less numerous, sometimes crowded, spindle-shaped, constricted at the bases and more or less prolonged at the apices; tetrasporangia borne below the apices of ultimate branchlets; cystocarps ovate, sessile on the ultimate branchlets; texture fleshy cartilaginous; color light straw red.

Florida; West Indies; Mexico; Bermuda.

Sometimes fairly abundant on Bogue Beach, Beaufort, N. C.

The determination of the specimens referred to this species is made with some doubt, but the plants resemble, in most respects, specimens of this species in the herbaria visited, and seem to agree with the description of the species. Among these Beaufort specimens there is considerable variation, the habit being irregular or fairly regular, the branching being more or less profuse, and the apices being conspicuously prolonged, slightly prolonged, or sunken; the habit is usually open; two specimens from Bogue Beach, August, 1907, and August, 1908, respectively, have the habit of *Gracilaria confervoides*, bearing elongated branches arising regularly, and rather few, inconspicuous branchlets. Only tetrasporic fruits have been observed. Whether this determination is correct or not, the species may be expected within

our range. If our plants belong to this species, this constitutes their northern known limit, since the specimens referred to this species by Farlow (1882, p. 167) are now attributed, with considerable doubt, to *C. dasyphylla*.

This species is distinguished from *C. atropurpurea* by its larger size, looser habit, longer branchlets, less acute apices, and lighter color. It is distinguished from *C. tenuissima*, which it resembles in habit, by its usually larger size, considerably coarser fronds, and less regular branching.

3. Chondria tenuissima (Goodenough and Woodward) Agardh.

Fucus tenuissimus, Goodenough and Woodward, 1797, p. 215, pl. 19.
Chondria tenuissima, Agardh, 1822, p. 352 (excluding synonyms).
Chondria tenuissima, Harvey, 1853, p. 21, pl. 18 F.
Chondriopsis tenuissima, Farlow, 1882, p. 166.
Chondria tenuissima, De Toni, 1903 p. 834.
P. B.-A. No. 42.

Fronds slender, 6 to 24 cm. tall, about 0.5 to 1.5 mm. in diameter in main stems, pyramidal in outline, irregularly, alternately branched, main branches spreading, bearing more or less numerous secondary branches, and slender, spindle-shaped, spreading branchlets about 4 to 10 mm. long, apices conspicuously prolonged, secondary branches and branchlets tapering at the bases; tetrasporangia borne below the apices of ultimate branchlets; cystocarps ovate, sessile on the ultimate branchlets, sometimes occupying almost the entire branchlet.

Warm and temperate North Atlantic; Mediterranean.

Var. baileyana (Montagne) Farlow, Anderson, and Eaton. Pl. CVII, fig. 3.

Laurencia baileyana, Montagne, 1849, p. 63.
Chondria baileyana, Harvey, 1853, p. 20, pl. 18 A.
Chondriopsis tenuissima var. *baileyana*, Farlow, 1882, p. 166.
Chondria tenuissima var. *baileyana*, Farlow, Anderson, and Eaton, 1889, A. A. B. Ex. No. 187.
Chondria tenuissima var. *baileyana*, De Toni, 1903, p. 836.
A. A. B. Ex. No. 187.
P. B.-A. No. 43.

Frond very slender, 3.5 to 20 cm. tall, about 0.2 to 1 mm. in diameter in main stems; more or less loosely branched, branches elongated, erect, rather simple, bearing very slender, spindle-shaped or club-shaped branchlets, tapering at the bases but obtuse at the apices, apices slightly or not at all prolonged.

New England to North Carolina; Europe.

Fairly abundant in harbor north of laboratory, Beaufort, N. C., abundant on Fort Macon jetties, April, 1908, 10 cm. above to 10 cm. below low water, few very slender specimens on shells and other algæ between jetties, Fort Macon, July, 1909, only tetrasporic fruits observed.

This species is usually distinguished without difficulty by its slender habit and long, slender branchlets, although some specimens bear resemblances to *C. littoralis* and *C. atropurpurea*. The variety is distinguished from the species by its more slender habit and the shape of its branchlets, these tapering at the bases and being blunt, obtuse, and slightly or not at all prolonged at the apices, having the shape of a club rather than that of a spindle. Neither the species nor the variety was observed here in May, 1907. This is the southern known limit of the variety.

4. Chondria dasyphylla (Woodward) Agardh. Figs. 38–40; Pl. CVII, figs. 2 and 4.

Fucus dasyphyllus, Woodward 1794, p. 239.
Chrondria dasyphylla, Agardh, 1822, p. 350.
Chondria dasyphylla, Harvey, 1853, p. 20.
Chondriopsis dasyphila, Farlow, 1882, p. 166 (excluding variety).
Chondriopsis littoralis, Farlow, 1882, p. 167. (?)
Chondria dasyphylla, De Toni, 1903, p. 842.
A. A. B. Ex. No. 186.
P. B.-A. No. 142.

Fronds robust, coarse, 7 to 20 cm. tall, about 0.5 to 2 mm. in diameter in main stems, often pyramidal in outline, often sparingly branched below, usually densely branched above, branching alternate, fairly regular, sometimes opposite or fasciculate, main branches elongated, spreading, more or less decompound, tapering gradually toward the apices, secondary branches more or less elongated and tapering, ultimate branchlets usually 2 to 5 mm., sometimes up to 2 cm., long, sometimes borne on the main branches,

usually abundant on the secondary branches, arising singly or in clusters, markedly constricted at the bases, usually more or less truncate at the apices, cylindrical, club-shaped to top-shaped, apices more or less markedly sunken, usually truncate, sometimes obtuse and rounded, sometimes almost oblong, often with a short, pointed projection; tetrasporangia borne below the apices of ultimate branchlets; cystocarps round-ovate, sessile, lateral below the apices of ultimate branchlets, which are often pointed at the apices, these points later being pushed to one side by the growth of the cystocarps; texture fleshy-cartilaginous, rigid, brittle; color usually dark, purplish red, sometimes yellowish pink.

Warm and temperate North Atlantic; Mediterranean.

Beaufort, N. C.: Abundant on Fort Macon jetties, 0 to 50 cm. below low water, June to October, fruiting throughout the summer and autumn, an occasional battered specimen found during the winter; abundant in harbor south of laboratory, summers 1903 and 1904; fairly abundant on coral reef offshore, May, 1907, and few slender specimens, August, 1914 and 1915. Ocracoke, N. C.: One faded specimen on jetty, August, 1907.

In this region the species is fairly uniform, usually being distinguished by its coarse, rigid, brittle, dark, purplish red fronds densely branched in the upper portions and by the ultimate branchlets, many of which are extremely short and shaped like a top. Tetrasporic and cystocarpic specimens are abundant throughout the summer and autumn, but antheridial plants are rare. Specimens which seemed to be young plants of this species were observed, in fair abundance, on Fort Macon jetties in April, 1908, but the determination could not be made with certainty, and no plants of the species were observed in May, 1907. The species had almost disappeared on October 17, 1908. Specimens have been collected on Fort Macon jetties twice during the winter, a few small, matted plants, 2 to 4.5 cm. tall, in December, 1908 (Pl. CVII, fig. 2), and one battered fragment in February, 1909. While these plants suggest the probability that the species may winter in this condition, they were not found with sufficient regularity during the winter to establish the point. Plants collected June 12, 1909, were large and well developed. This species has not been observed on Shackleford jetties, nor in the harbor since 1904.

Young stages of this species are frequently observed attached to mature fronds of the same species or to other algæ, especially *Padina vickersiæ*. These appear at first as small, convex disks (fig. 40A), from the middle of which single upright shoots arise, and later give off downward-growing filamentous attaching organs from their basal cells (fig. 40B).

From the bases of mature fronds many short branches grow down and branch profusely, sometimes finally into filamentous branches consisting of single rows of large, thick-walled cells. When these branches reach the substratum they spread out into irregular disks, forming a secure attachment for the frond. The bases of the mature fronds are usually covered by a spongelike animal growth and by small tubes of animals, apparently worms.

5. **Chondria sedifolia** Harvey. Pl. CVIII, figs. 1 and 2.

Chondria sedifolia, Harvey, 1853, p. 19, pl. 18 G.
Chondriopsis dasyphila var. *sedifolia*, Farlow, 1882, p. 166.
Chondria sedifolia, De Toni, 1903, p. 845.
P. B.-A. No. 594.

Fronds robust, of medium coarseness, 2.5 to 27 cm. tall, about 0.4 to 1 mm. in diameter in main stems, uniformly branched throughout, branching profuse, usually alternate, sometimes multifid, main branches more or less elongated, straight or curved, spreading in all directions, ultimate branchlets about 2 to 5 mm. long, sometimes borne on the main branches, usually abundant on the secondary branches, usually arising singly, obovate-oblong or somewhat elliptic, usually markedly contracted at the bases, obtuse or acute, usually truncate, at the apices, apices sunken; tetrasporangia borne below the apices of the ultimate branchlets; cystocarps ovate, opening by a conspicuous apical pore, sessile below the apices of ultimate branchlets, the apices later being pushed to one side by the growth of the cystocarps; texture gelatinous-cartilaginous; color reddish brown to pinkish straw.

New England to Florida and West Indies.

Beaufort, N. C.: Fairly abundant on jetties, and attached to Zostera, shells, etc., between jetties at Fort Macon, 15 to 45 cm. below low water, May to September since 1906, not found in earlier years, fruiting throughout the season; one specimen on Fort Macon jetty, December, 1908; fairly abundant on coral reef offshore, July, 1915; fairly abundant in Core Sound on one jetty at Lecklys Island, July, 1908.

This species is distinguished from *C. dasyphylla* by its more slender form, its habit, and its generally lighter color. The branches are borne fairly uniformly throughout and not in clusters in the upper part of the frond; the ultimate branches are more slender and often shorter than in *C. dasyphylla*, but it lacks the short, top-shaped branchlets frequently found in the latter species, and the apices, so far as has been observed, do not bear short, pointed projections. The species has not been found on Shackleford jetties or in the harbor.

Genus 3. **Polysiphonia** Greville.

Polysiphonia, Greville, 1824a, p. 308.

Frond erect (or creeping at first, later becoming erect), usually terete, sometimes slightly flattened, laterally and radially or dichotomously branched, usually elongated and delicate, slender and flexible, or bristlelike and rigid; structure cellular or filamentous-cellular, consisting of a central row of cells surrounded by a circle of 4 to 24 pericentral cells, this primary structure remaining naked or being clothed in the older parts by a layer of small, cortical cells; sometimes small secondary cells are formed outside of and alternating with the pericentral cells, sometimes the central axis is inclosed by a later-developed layer of rhizoidal filaments; the central cells and inclosing pericentral cells are of the same length, so that the frond has a segmented appearance which is evident throughout or, in the corticated species, only in the younger portions; growth monopodial, apical cell transversely or obliquely segmented, trichoblasts often borne in regular order, somewhat persistent, but finally evanescent, secondary shoots often borne in regular order; tetrasporangia arising from the pericentral cells of ultimate branchlets, usually singly and in spiral rows, sometimes in straight rows, covered by special cover cells, triangularly divided; antheridia lanceolate or long elliptical, attached by short stalks to trichoblasts near the apices; procarps borne on trichoblasts near the apices; cystocarps becoming secondarily attached to branches, borne on short stalks or sessile, conspicuous, oval or urn-shaped, pericarp thin, opening by prominent carpostome, gonimoblast composed of branched filaments radiating from a basal placenta, bearing single, large, elongated, pear-shaped carpospores in their terminal segments; tetrasporangia, antheridia, and cystocarps borne on separate plants; sexual and asexual plants alternating with each other in the life cycle.

About 130 species of varied habit and size, often separated by variable characters, in all seas. The genus is easily recognized, but determinations of the species are usually difficult. This is the central, characteristic genus of the family about which all the others are grouped.

KEY TO SPECIES.

a. Frond with four pericentral cells, no cortex ..... *b*.
b. Branching somewhat dichotomous, segments about 1.5 diameters long below, 2 to 5 diameters in branches ..... 1. *P. havanensis* (p. 502)
bb. Branching pinnate, segments about 1 diameter long throughout, sometimes up to 2.5 diameters ..... 2. *P. harveyi* (p. 503).
aa. Frond with more than four pericentral cells, no cortex over most of thallus ..... *c*.
c. Frond with 5 to 8 (usually 6) pericentral cells, segments 1 to 3 diameters long, dichotomous ..... 3. *P. denudata* (p. 503).
cc. Frond with 8 to 20 (usually 16) pericentral cells, segments 1 to 4 diameters long, branching pinnate ..... 4. *P. nigrescens* (p. 504).

1. **Polysiphonia havanensis** Montagne. Pl. CVIII, fig. 3.

Polysiphonia havanensis, Montagne, 1837, p. 352.
Polysiphonia havanensis, Harvey, 1853, p. 34.
Polysiphonia havanensis, De Toni, 1903, p. 894.
P. B.-A. No. 1043.

Fronds forming erect tufts, 1 to 8 cm. tall, arising from creeping filaments, somewhat setaceous below, capillary above, soft and flaccid, branching somewhat dichotomous, irregular, decompound, with many lateral branches, branches distant, divided into fine branchlets and more or less densely tufted toward apices, sometimes tufted throughout, secondary branches very slender, branchlets usually elongated, tapering; pericentral cells 4, segments 1.5 diameters long below, 2 to 3 diameters in small branches, 3 to 5 diameters in large branches, less than 1 diameter in branchlets, no cortex; tetrasporangia scattered, usually occurring singly, sometimes in pairs, in swollen portions of branchlets; cystocarps small, ovate on upper branches; color light yellowish red to dark brownish red.

Florida; West Indies.

About 10 specimens, Bogue Beach, Beaufort, N. C., February, 1909.

This species may be distinguished from *P. harveyi*, the only other species with four pericentral cells thus far found at Beaufort, by its finer habit, somewhat dichotomous branching, longer segments, and lighter brownish color. Since, however, other species with four pericentral cells may enter this region, no determination should be made without a careful study of all the characters.

This is the northern known limit of the species. It seems probable that the specimens found here were brought by the Gulf Stream from Florida or the West Indies, since it is not likely that the species could grow in winter at a more northern station.

2. **Polysiphonia harveyi** Bailey. Fig. 41A; Pl. CVIII, fig. 4c.

Polysiphonia harveyi, Bailey, 1848, p. 38.
Polysiphonia harveyi, Harvey, 1853, p. 41, pl. 17 A.
Polysiphonia harveyi, Farlow, 1882, p. 171, pl. 15, f. 3–4.
Polysiphonia harveyi, De Toni, 1903, p. 897.
A. A. B. Ex. No. 133a, b.
P. B.-A. Nos. 888, 1400.

Fronds forming globose, bushy tufts 2 to 15 cm. tall, setaceous, rather rigid, branching abundant, decompound, pinnate, sometimes irregular, usually alternate, branches more or less elongated, spreading, sometimes angularly bent, tapering and sometimes divided into numerous fine branchlets toward the apices, secondary branches sometimes almost as coarse as the primary ones, branchlets arising irregularly, more or less abundant over the entire frond, about 1 to 2 mm. long, spinelike, rigid, spreading, tapering toward the apices, simple or forked, often shed from older plants; pericentral cells four, segments short throughout, about 1 diameter in length, sometimes less, sometimes up to 2.5 diameters, no cortex, but in the older portions of the frond four small secondary cells occur outside of and alternating with the pericentral cells; tetrasporangia forming wartlike swellings in the branchlets; antheridia ellipsoid· cystocarps broad-ovate, toward the apices of small branches; color dark purplish red.

Nova Scotia to North Carolina.

Occasionally fairly abundant on buoys and on algæ thrown on Bogue Beach, Beaufort, N. C., July to October, fruiting. Fairly abundant on buoy in sound, Port Royal, S. C., August, 1909 (?).

This species may be distinguished from *P. havanensis*, the only other species with four pericentral cells thus far found at Beaufort, by its coarser habit, more or less regular pinnate branching, shorter segments, and darker purplish-red color. It is the only identifiable species with four pericentral cells that has been found growing in this region. Specimens apparently belonging to this species were collected at Port Royal, S. C., but unfortunately were lost before they were compared with authentic specimens. It remains doubtful, therefore, whether Beaufort, N. C., or Port Royal, S. C., is the southern known limit of the species. Of the fruiting plants observed about 90 per cent were tetrasporic, 5 per cent male and 5 per cent female.

3. **Polysiphonia denudata** (Dillwyn) Kuetzing. Fig. 41B; Pl. CVIII, fig. 4a, b; Pl. CIX, figs. 1 and 2.

Conferva denudata, Dillwyn, 1809, p. 85, pl. G.
Hutchinsia variegata, Agardh, 1824, p. 153.
Polysiphonia variegata, Zanardini, 1841, p. 60.
Polysiphonia denudata, Kuetzing, 1849a, p. 824.
Polysiphonia variegata, Harvey, 1853, p. 45.
Polysiphonia variegata, Farlow, 1882, p. 173.
Polysiphonia variegata, De Toni, 1903, p. 922.
A. A. B. Ex. No. 135.
P. B.-A. Nos. 245, 639.

Fronds forming dense, globose tufts, 2 to 25 cm. tall, setaceous and rather rigid below, capillary and flaccid above, branching dichotomous, decompound, abundant, axils spreading below, acute

above. branches sometimes elongated and somewhat zigzag, gradually tapering, and divided into numerous fine branchlets toward the apices, branchlets arising laterally, often forming dense fastigiate tufts, especially toward the apices; pericentral cells six to eight, usually six, rarely five, segments 1 diameter long or less below, 2 to 3 diameters above, no cortex; tetrasporangia in somewhat torulose series in the branchlets; antheridia linear-oblong, acute at apices; cystocarps broad-ovate, toward the apices of small branches; color dark brownish or blackish purple.

Warm and temperate North Atlantic.

Occasionally abundant on buoys, Beaufort, N. C., July to September, sometimes fruiting. One mass on buoy in Sound, Port Royal, S. C., and very abundant on *Gracilaria multipartita* var. *angustissima* at mouth of one creek, August, 1909.

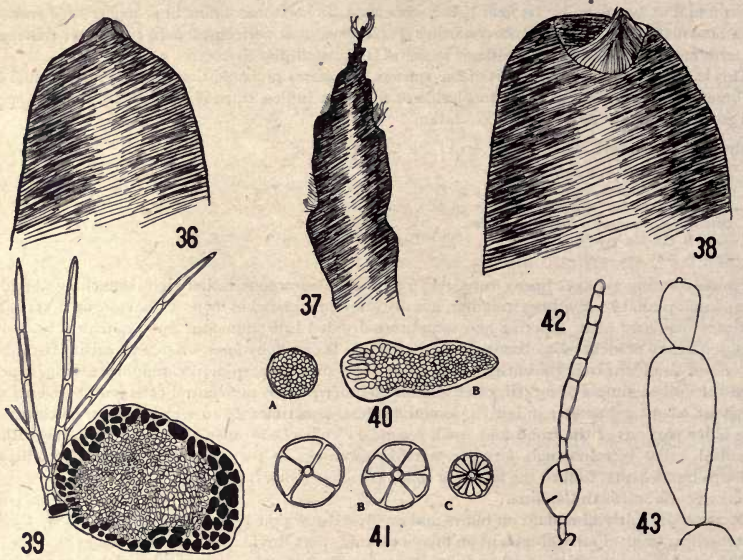


Fig. 36.—*Chondria littoralis*, apex of branch, × 40.
Fig. 37.—*Chondria littoralis* (?), apex of branch, × 40.
Fig. 38.—*Chondria dasyphylla*, apex of branch, × 40.
Fig. 39.—*Chondria dasyphylla*, anthreidium, × 157.
Fig. 40.—*Chondria dasyphylla*, young plants, × 157.
Fig. 41.—*Polysiphonia* spp., cross sections of stems. A. *P. harveyii*. B. *P. denudata*. C. *P. nigrescens*. × 40.
Fig. 42.—*Spermothamnion investiens*, partly divided tetrasporangium producing vegetative filament, × 263.
Fig. 43.—*Griffithsia* sp. × 40.

This is the only determinable species having six pericentral cells observed in this region. The habit, while more or less dense, is characteristic, and the determination is less difficult than in most species of the genus. The plants growing on the buoys are small (2 to 4 cm.), while those from the creek at Port Royal are 6 to 15 cm. tall. According to Harvey, this species is very abundant in the harbor of Charleston, S. C., during January and February.

4. **Polysiphonia nigrescens** (Hudson) Greville. Fig. 41C; Pl. CIX, fig. 3.

Conferva nigrescens, Hudson, 1778, p. 602.
Polysiphonia nigrescens, Greville, in Hooker, 1833, p. 322.
Polysiphonia nigrescens, Harvey, 1853, p. 49.
Polysiphonia nigrescens, Farlow, 1882, p. 174.
Polysiphonia nigrescens, De Toni, 1903, p. 940.

Fronds forming erect tufts 4 to 30 cm. tall, setaceous and rather rigid below, flaccid and much branched above, branching pinnate, alternate, decompound, rather regular, young branches usually

pectinate, older ones corymbose above, virgate and beset with short thornlike branchlets below, gradually tapering and more or less divided into fine branchlets toward the apices, branchlets more or less subulate, often compound, arising in clusters over a considerable portion of the frond or especially toward the apices; pericentral cells 8 to 20, usually 16, segments 1 to 4 diameters long, usually 1 to 1.5 diameters, upper and lower ones shorter, no cortex over most of the frond, but sometimes with a thin cortex over the older portions; tetrasporangia forming wartlike swellings in the distorted branchlets; antheridia very long, elliptical, often curved; cystocarps broad-ovate; color dark brownish purple.

Warm and temperate North Atlantic.

Beaufort, N. C.: Fairly abundant on Fort Macon and Shackleford jetties, May, 1907; fairly abundant all over harbor, abundant on Fort Macon jetties, very abundant on Shackleford jetties, and fairly abundant on Bogue Beach, April, 1908, fruiting.

This is an exceedingly variable species, many forms having been described. The habit may be robust with branchlets borne in close pectinate series throughout the frond, or more slender, with the branches more elongated and the branchlets borne in close tufts, especially toward the apices. Usually the branchlets are broken off from the lower parts of the frond, and the remnants of these remain as short, thornlike processes. Often the apices are very finely divided, forming dense, wedge-shaped tufts. Many of these differences seem to depend on the size and age of the plant.

The Beaufort plants have a loose habit, with regular, alternate, pinnate branches, beset below with short thornlike processes, and bearing branchlets in not very dense tufts toward their apices.

This is the only species observed in this region with as many as 16 pericentral cells. In spite of the variations, the determination is not very difficult. It is the only species of the genus so far found at Beaufort during the spring.

Since the identity of *Conferva nigrescens* Hudson is doubtful, it is questionable whether this species should be called *P. nigrescens* or *P. fucoides*, a specific name applied by Hudson to what is undoubtedly the present species. It has, however, seemed proper to keep the current name until it can be clearly shown that this should be changed.

Besides the plants mentioned above, numerous indeterminable small specimens and fragments belonging to this genus have been found at Fort Macon and Shackleford, on buoys, on Bogue Beach, in a tide pool at Fort Macon, and in the harbor, growing on jetties, buoys, shells, other algæ, or animals, or floating free. Some of these resembled *P. harveyi*, some resembled *P. denudata*, while some were too small or too fragmentary to be related to any species. During July and August, 1904, broken fragments of a species with four pericentral cells formed large masses along Bogue Beach and covering the bottom within the inlet at Fort Macon, being the predominant form found there at that time. In December, 1908, tetrasporic specimens 1.5 to 4 cm. tall were collected on Fort Macon jetty, with fine capillary filaments, somewhat dichotomously branched, having four to six pericentral cells. Fruiting specimens about 2 cm. tall, apparently having seven pericentral cells, were found at Pawleys Island near Georgetown, S. C., August, 1909.

Genus 4. **Brongniartella** Bory.

Brongniartella, Bory, in Dictionnaire classique d'histoire naturelle, tome 2, p. 516, 1822.

Frond erect, terete, radially constructed, usually laterally, sometimes dichtomously, branched; structure cellular or filamentous-cellular, with a single circle of five or seven (rarely four) pericentral cells, naked or sooner or later surrounded by a dense rhizoidal cortex, apical growth monopodial, apical cell transversely divided, the entire frond or the younger parts densely covered by spirally arranged, usually more or less dichotomous, colored trichoblasts, lateral branches arising from the basal cells of trichoblasts, forming elongated, vegetative branches or transformed into short, fruiting branches; tetrasporangia numerous, occurring singly in spiral rows in more or less transformed branchlets, triangularly divided; antheridia, procarps, and cystocarps as in Polysiphonia.

About eight species, in warm seas.

The genus is distinguished from Polysiphonia by the persistent trichoblasts and the consequent characteristic habit. It is distinguished from Dasya by its monopodial growth.

Brongniartella mucronata (Harvey) Schmitz. Pl. CIX, fig. 4.

Dasya mucronata, Harvey, 1853, p. 63.
Brongniartella mucronata, Schmitz, 1893a, p. 218.
Brongniartella mucronata, De Toni, 1903, p. 1012.
A. A. B. Ex. No. 2 (*Dasya mucronata*).
P. B.-A. No. 247 (*Dasya mucronata*).

Fronds robust, rather terete, 3 to 20 cm. tall, about 0.5 to 1 mm. in diameter in main stems, one or more arising from a basal, disklike expansion, branching usually lateral and distant, sometimes dichotomous, lower portions of the main stem and larger branches naked, smaller branches and apical portions of larger ones densely covered by monosiphonous, dichotomous, rather rigid, spreading trichoblasts going out on all sides from the cortical layer and mucronate at the apices; pericentral cells five, segments not conspicuous, about 0.5 diameter long in the main stem and larger branches, 1.5 to 2 diameters in smaller branches, covered throughout by a dense cortex; tetrasporangia in somewhat spiral row among the cortical cells of scarcely altered branchlets; antheridia and cystocarps unknown; texture firm, cartilaginous; color of the stem and branches dull, brownish-red, that of the trichoblasts usually brighter, rosy red.

Florida and West Indies.

Occasional on Bogue Beach, Beaufort, N. C., summer and autumn, usually sterile, rarely tetrasporic, few specimens, 3 to 6 cm. tall, dredged on coral reef offshore, May, 1907, and July, 1915.

This species is easily recognized. Neither the species nor the genus is known elsewhere on our coast north of Florida.

Genus 5. **Bostrychia** Montagne.

Bostrychia, Montagne, 1838, p. 39.

Frond usually creeping with erect branches, less often erect, more or less flattened, sometimes apparently terete, branching usually distichous and alternate, sometimes somewhat dichotomous or radial, longer branches bearing two lateral rows of short branches, usually of limited growth, ultimate branchlets simple or branched, often monosiphonous; structure cellular, with a circle of 4 to 11 pericentral cells, the number often varying from base to apex, naked or sooner or later inclosed by one or more layers of cortical cells, the segments sometimes becoming indistinct from the transverse and longitudinal division of the pericentral cells, apical growth monopodial, apices often monosiphonous, often bent or inrolled, apical cell alternately transversely and obliquely divided; tetrasporangia occurring in ultimate, more or less transformed, stichidiumlike branchlets, arising in whorls of 4 to 6 from the pericentral cells, triangularly divided, more or less covered by a layer of small cover cells; antheridia composed of a larger or smaller number of the middle, thickened segments of simple, cylindrical branchlets, the spermatangia occurring in a dense layer over the surface; procarps numerous in single or double rows, embedded in the cortex of slightly thickened branchlets; cystocarps broad-ovate, conspicuous, usually occurring singly, apparently at the apices of branchlets, pericarp fairly thin, opening by a conspicuous terminal carpostome, gonimoblast composed of compressed or more elongated dichotomous-fastigiate filaments, forming single long pear-shaped or club-shaped carpospores from their terminal segments.

About 30 species, mostly in warm regions, usually in brackish water at the mouths of rivers, often extending into fresh water, some species known only in fresh water.

Bostrychia rivularis Harvey.

Bostrychia rivularis, Harvey, 1853, p. 57, pl. 14 D.
Bostrychia rivularis, Farlow, 1882, p. 176.
Bostrychia rivularis, De Toni, 1903, p. 1157.
A. A. B. Ex. No. 54.
P. B.-A. No. 140.

Fronds forming dense tufts, 1 to 4 cm. high, arising from creeping filaments attached to the substratum at intervals by basal disks, capillary, slender, rather rigid, branching decompound, pinnate, alternate, usually distichous, lower branches spreading, almost horizontal, upper ones rather erect, somewhat fastigiate, apices incurved, branchlets usually slightly curved, more or less acute or obtuse at the apices, polysiphonous almost to the apex or terminating in a more or less prolonged monosiphonous portion; pericentral cells 6 to 8 in the principal branches, divided once transversely, thus being half as long as the central cells, segments about 0.5 to nearly 1 diameter long, no cortex; tetrasporangia in stichidiumlike branchlets; cystocarps ovate, terminal on the short, naked, lower branchlets; color dull, brownish purple.

New England to Florida and West Indies.

Very abundant in harbor, Southport, N. C., in brackish water, forming dense covering on wall alongshore from high tide to 30 cm. below high-tide line, fairly abundant on shells alongshore, August, 1909.

This species is easily recognized, having a structure superficially resembling that of Polysiphonia, with regularly, alternately, distichously branched portions arising from creeping filaments, and tetrasporangial branches somewhat resembling the stichidia of Dasya. Its upright branches have a flattened habit, and the main stems have a zigzag appearance, due to their manner of branching. It has not been observed at Beaufort, but may be expected there in brackish water and in similar situations elsewhere.

Genus 6. **Herposiphonia** Nægeli.

Herposiphonia, Nægeli, 1844, p. 238.

Frond creeping, delicate, small, attached at intervals by short, rootlike filaments, rarely entirely erect, terete or flattened, branching lateral, alternate, regular, long and short branches sharply distinct, single, long, creeping branches of unlimited growth arising alternately in two rows from the flanks of the creeping filaments at each fourth segment, single short erect branches of limited growth arising alternately in one or two rows from the dorsal surface of the creeping filaments at all the other segments, creeping filaments dorsiventrally constructed, revolute at the apices, erect filaments dorsiventrally or radially constructed, at first revolute, later becoming straight at the apices and bearing more or less evanescent trichoblasts; structure consisting of a central row of cells surrounded by a circle of numerous (usually 12 to 18) pericentral cells, of the same length, so that the frond has a segmented appearance, no cortex, growth monopodial, apical cell transversely or somewhat obliquely divided; tetrasporangia occurring in more or less broken single rows in the lower or middle portions of erect, short branches, covered by special cover cells, triangularly divided; antheridia lanceolate or long elliptical, attached by short, monosiphonous stalks to trichoblasts toward the apices of erect, short branches; procarps borne on the trichoblasts at the apices of erect short branches; cystocarps as in Polysiphonia.

About 15 species, in warm seas.

Herposiphonia tenella (Agardh) Ambronn. Pl. CX, fig. 1.

Hutchinsia tenella, Agardh, 1828, p. 105.
Polysiphonia tenella, J. Agardh, 1842, p. 123.
Polysiphonia pecten-veneris var. *β*, Harvey, 1853, p. 46, pl. 16 D.
Herposiphonia tenella, Ambronn, 1880, p. 162.
Herposiphonia tenella, De Toni, 1903, p. 1051.
P. B.-A. Nos. 1044, 1943.

Fronds forming a very fine capillary mat or fringe, composed of creeping filaments with short erect branches, primary filaments decompound, erect, short branches, slender, curved, tapering slightly toward the apices, borne in two rows, coming to lie approximately in one row; pericentral cells 8 to 10, segments 1.5 to 2 diameters long in the primary filaments, about 1 diameter long in the branchlets; tetrasporangia occurring singly in single, straight, unbroken rows of 20 to 30 in erect, short branches; antheridia often borne on every segment for about one-third the length of the branch, beginning about the middle and extending toward the apex; cystocarps usually borne singly on short stalks; texture velvety; color purplish red.

Florida and West Indies; Mediterranean.

Abundant on Fort Macon and Shackleford jetties, Beaufort, N. C., throughout the year, on other algæ, especially *Padina vickersiæ*, and sometimes on the Polyzoan *Bugula turrita*, fruiting August and September, probably throughout the summer and autumn. Fairly abundant on *Dictyota dichotoma*, in sound near inlet, Wrightsville Beach, N. C., July, 1909. Fairly abundant on shells and other algæ, in sound near inlet, Pawleys Island, near Georgetown, S. C., August, 1909.

This species will not be mistaken for any other occurring in this region, being easily recognized by its appearance of a creeping Polysiphonia, forming purplish red, velvety mats or fringes composed of horizontal filaments with upright branches. The species is diœcious. Often all the filaments observed on a single specimen of the host were either sexual (both male and female) or tetrasporic, but sometimes both tetrasporic and sexual plants occurred together.

This is the northern known limit of the species and of the genus.

Genus 7. **Dasya** Agardh.

Dasya, Agardh, 1824, p. XXXIV.

Frond erect, terete, radially constructed, laterally and radially somewhat irregularly branched, long and short branches intermixed; structure cellular or filamentous-cellular, with a circle of five (very rarely four) pericentral cells, naked or inclosed by a more or less dense rhizoidal cortex, apical growth sympodial, the entire frond or the younger parts densely covered by spirally arranged, repeatedly forked, colored trichoblasts; tetrasporangia in whorls (usually of five sporangia) at each segment of special lanceolate branchlets (stichidia) arising as young branches of the trichoblasts and attached to these by monosiphonous stalks, covered by special cover cells when young, uncovered when mature, triangularly divided; antheridia arising as branches of the trichoblasts, lanceolate-conical, ending in a sterile apex, borne on a monosiphonous stalk; procarps numerous near the growing apices of more or less developed lateral branches; cystocarps ovate-globose or urn-shaped, borne laterally on smaller branches, pericarp rather thin, opening by a conspicuous terminal carpostome, gonimoblast composed of dichotomously branched filaments radiating from a basal placenta, forming oval or club-shaped carpospores singly or, rarely, in short chains of two to three spores from their terminal segments.

Thirty to forty species, in warm seas.

Dasya pedicellata Agardh. Pl. CX, fig. 2.

Dasya pedicellata, Agardh, 1824, p. 211.
Dasya elegans, Harvey, 1853, p. 60.
Dasya elegans, Farlow, 1882, p. 177, pl. 15, f. 1.
Dasya elegans, De Toni, 1903, p. 1201.
A. A. B. Ex. No. 51 (*Dasya elegans*).
P. B.-A. No. 545, Fasc. A, No. XXIII (*Dasya elegans*).

Fronds moderately robust, flexuous, terete, 4 to 90 cm. long, about 0.6 to 6 mm. in diameter in main stems, arising singly from a small basal disk, branching lateral, decompound, sparse or profuse, lower portions of the main stem and larger branches naked, smaller branches, and sometimes almost the entire plant, very densely covered by conspicuous, monosiphonous, dichotomous, flaccid trichoblasts going out on all sides from the cortical layer, not tapering toward the apices; pericentral cells

five, in the older portions surrounded by one or more layers of smaller secondary cells and always inclosed by a layer of small, cortical cells; tetrasporangia numerous, borne in linear-lanceolate stichidia attenuate at the apices; cystocarps urn-shaped, often excentric, usually single, rarely 2 to 3 together, borne near the apices of short lateral branches; texture soft gelatinous-cartilaginous, flaccid; color light to dark purplish red; tetrasporangia, antheridia, and cystocarps borne on separate plants; sexual and asexual generations alternating regularly in the life cycle.

New England to West Indies; Canary Islands; Mediterranean.

Throughout harbor, and on Fort Macon and Shackleford jetties, Beaufort, N. C., 15 to 45 cm. below low-tide level, very abundant April, 1908, abundant May, 1907, few specimens on coral reef offshore, May, 1907. Collected during the winter and spring 1908–9, as follows: Fort Macon jetty, December, one small fragment; April, large, fruiting; May, small, battered; Bogue Beach, February, sterile; March, fruiting; April, large, fruiting. Few specimens Bogue Beach, July, 1903, and September, 1904; few small specimens attached to stem of *Leptogorgia virgulata* on Fort Macon jetty, August, 1904. One specimen about 1 cm. tall on shell in sound near inlet, Pawleys Island, near Georgetown, S. C., August, 1909.

This species will not be mistaken for any other, being easily recognized by its dense covering of capillary, dichotomous filaments. In this region the species seems to appear in occasional specimens during the winter, reaches its maximal development in April, and almost or entirely disappears by June. Further study is needed to show how it survives from one spring to another, since the occasional specimens observed at other seasons have not been found with sufficient regularity to account for the maintenance of the species.

Family 5. CERAMIACEÆ (Bonnemaison) Nægeli.

Frond terete or flattened, often filamentous, richly laterally or dichotomously branched, usually erect, sometimes partially or almost entirely horizontal, rarely parasitic, structure various, usually composed of naked or more or less corticated filaments; tetrasporangia occurring singly or in groups, in special branches or scattered over the frond, external or sunken in the cortical layer, usually triangularly, sometimes cruciately, divided; antheridia scattered over the thallus in various positions, bearing numerous crowded spermatangia; carpogonia usually closely associated with cells which, after fertilization, produce the auxiliary cells, forming definite procarps of various forms, external, scattered over the thallus or occurring in definite regions, often having two auxiliary cells associated with one carpogonium; cystocarps external or more or less embedded in the cortex, conspicuous, sometimes occurring in pairs, often having two gonimoblasts associated in a single cystocarp, naked or inclosed by special filamentous branchlets forming a more or less lax pericarp, gonimoblast arising from a basal placenta, sometimes compact, usually divided into several more or less conspicuous, usually rounded lobes, consisting of richly branched filaments forming carpospores from nearly every cell.

Nearly 400 species, in all seas, especially in warm regions; two species reported as terrestrial.

KEY TO GENERA.

a. Thallus consisting of monosiphonous filaments entirely or almost entirely without cortex.....*b*.

b. Thallus consisting of erect, laterally branched, filamentous branches arising from horizontal filaments; cystocarps terminal, bearing two gonimoblasts. . 1. Spermothamnion (p. 510).

bb. Thallus erect, consisting in part of long barrel-shaped or obovoid cells in moniliform filaments; cystocarps terminal, sometimes appearing lateral at the nodes. 2. Griffithsia (p. 511).

bbb. Thallus erect, main filaments often corticated below with descending rhizoidal filaments; cystocarps lateral, sessile .....3. Callithamnion (p. 511).

aa. Thallus consisting of a monosiphonous central axis partially or entirely surrounded by cortical layers.....*c*.

c. Thallus laterally branched, cortex continuous throughout or lacking only on the finer divisions.....4. Spyridia (p. 512).

cc. Thallus dichotomously branched, forcipate at apices, cortex continuous or present only at the nodes.....5. Ceramium (p. 513).

Genus 1. **Spermothamnion** Areschoug.

Spermothamnion, Areschoug, 1847, p. 334.

Thallus composed of erect, naked, monosiphonous filaments arising from creeping filaments attached to the substratum at intervals, erect filaments oppositely or alternately branched; tetrasporangia sessile, occurring singly or in groups on short lateral branchlets, triangularly divided; antheridia ovoid-oblong, sessile on short lateral branchlets, sometimes terminal, composed of minute hyaline cells grouped around a central axis; procarps usually terminal on lateral branchlets, always with two auxiliary cells; cystocarps globose, small, terminal on lateral branchlets, sometimes naked, usually inclosed by short upgrowing, filamentous branchlets, pericarp lacking, containing two gonimoblasts which are small, compressed, and bear numerous single, rounded carpospores radiating in all directions.

About 15 species, in warm and temperate seas.

Spermothamnion investiens (Crouan) Vickers. Pl. XCI, fig. 1.

Callithamnion investiens, Crouan, in Schramm and Mazé, 1865, p. 7.
Callithamnion investiens, Crouan, in Mazé and Schramm, 1870, p. 141.
Spermothamnion investiens, Vickers, 1905, p. 64.

Thallus forming dense woolly tufts, closely enveloping the host plant; primary filaments creeping, attached to the substratum at intervals by unicellular, rhizoidal structures flattened at their ends to form attaching disks, secondary filaments erect, numerous, 1 to 3 mm. tall, 14 to 16 mic. wide, sparingly alternately branched, sometimes simple, branches usually simple, segments 30 to 100 mic. long, usually 55 to 70 mic.; tetrasporangia occurring singly, terminating short (usually one-celled), lateral branchlets, borne oppositely or secundly, ellipsoid or slightly obovate, sometimes almost globose, 30 to 40 mic. wide, 37 to 45 mic. long; antheridia oblong-ovate, borne singly at the apices of more or less prolonged lateral branches or of the main filaments; cystocarps situated like the antheridia; texture velvety; color rose.

West Indies.

Occasionally very abundant on Bogue Beach, Beaufort, N. C., on about half of the specimens of *Zonaria flava* found on the beach throughout the year, fruiting at all seasons, very abundant on about one-third of specimens of *Zonaria flava* dredged off coral reef, May, 1907.

The Beaufort plants are closely similar to Miss Vickers's specimens from Barbados. This species here forms dense, velvety mats covering in almost pure growths the main stems, branches, and larger ribs of the Zonaria. It has been found only on this host except in one instance when a battered specimen of *Brongniartella mucronata* on Bogue Beach had the lower part of its stem densely covered with filaments of this species. It seems very probable that all the plants of *Zonaria flava* found here have come from the coral reef offshore.

It has been noted by Farlow (1882, p. 119) and Lewis (1909, pp. 683, 684) that, in *S. turneri* (Mert.) Aresch, apparent tetraspores may occur on the same individual with procarps, cystocarps, or antheridia. The author has, in the present species, observed cystocarps on the same filaments with what appeared to be undivided tetrasporangia, but has not found cystocarps and mature tetraspores on the same plant. In one instance there was observed a structure (fig. 42) that appeared to be an imperfectly divided tetrasporangium which had continued its growth as a vegetative filament. At Beaufort the masses of Spermothamnion on some specimens of Zonaria seem to be entirely tetrasporic, but on other plants of the host antheridia, cystocarps, and tetraspores occur intermingled.

In spite of its small size, this is the most favorable species found in this region for the study of the structure of the procarp, the process of fertilization, and the development of the cystocarp. Since all the organs are entirely external, these structures appear with diagrammatic clearness, and fruits of all ages are often found in great abundance.

Genus 2. **Griffithsia** Agardh.

Griffitsia, Agardh, 1817, p. XXVIII.

Frond erect, filamentous, composed of simple rows of large, more or less long, cylindrical, barrel-shaped or obovoid cells, naked or possessed of whorls of evanescent, short, branched filaments, branching lateral or dichotomous; tetrasporangia occurring in whorls at the nodes, or on the inner side of short, fascicled branches, usually surrounded by sterile filaments, triangularly divided; antheridia forming compact tufts occupying positions similar to those of the tetrasporangia or densely covering the apices of terminal segments; cystocarps terminal on greatly shortened branches, sometimes appearing lateral at the nodes, usually several occurring together, inclosed by a tuft of sterile filaments, having one or, rarely, two gonimoblasts, gonimoblast usually compact, sometimes divided into several lobes, forming carpospores from nearly every cell.

About 25 species, especially in warm seas.

One small fragment found on Bogue Beach, Beaufort, N. C., August, 1904, seems, from its structure, to belong to this genus, but is insufficient for specific determination; several fragments showing the characteristic structure of the genus (fig. 43) were dredged from the coral reef offshore, August, 1914.

Genus 3. **Callithamnion** Lyngbye.

Callithamnion, Lyngbye, 1819, p. 123.

Frond erect, filamentous, composed of simple rows of cells, naked or, in many species, the main filaments corticated below by rhizoidal, descending filaments, branching abundant, dichotomous or lateral, in the latter case radial throughout, or distichous above, structure monopodial or sympodial, cells multinucleate; tetrasporangia occurring singly or in groups on the upper side of segments of upper branchlets, triangularly divided, sometimes transversely bipartite; antheridia forming small compact tufts of branched filaments of various forms situated on the upper side of upper branchlets; procarps occurring singly or in rows, intercalary on the upper branchlets, usually having two opposite auxiliary cells; cystocarps borne laterally on upper branchlets, sometimes appearing terminal, usually containing two gonimoblasts, sometimes only one, gonimoblasts divided into several successively formed, rounded lobes, producing numerous carpospores, pericarp and encircling branches lacking, but cystocarp inclosed by thin, gelatinous covering.

About 40 species, all marine, very difficult of determination, widely distributed, especially in warm seas.

This genus, which is abundantly represented in some other regions, has few species or individuals at Beaufort and has not been observed by the author elsewhere within our limits. The single species identified at Beaufort (*C. polyspermum*) is, however, reported from Charleston, and representatives will probably be found in other localities along our coast. In determining species, the habit and manner of branching are important characters, and as these distinctions are often difficult to make and some species are variable in these respects, determinations can be made only by careful comparison with authentic specimens.

Callithamnion polyspermum Agardh.

Callithamnion polyspermum, Agardh, 1828, p. 169.
Callithamnion polyspermum, Harvey, 1853, p. 234.
Callithamnion polyspermum, Farlow, 1882, p. 126.
Callithamnion polyspermum, De Toni, 1903, p. 1315

Frond capillary, forming more or less dense tufts 1 to 6 cm. tall, branching profuse, decompound, alternate, radial below, distichously pinnate above, pinnæ naked at the base, pinnulate above the middle; slightly corticated, segments of the main filaments 2 diameters long below, 4 diameters above, uppermost ones shorter; tetrasporangia numerous, secund on the inner side of the pinnules or scattered; cystocarps large, rotund-ovate, occurring singly or up to four or five together; texture flaccid; color bright, purplish rose.

Warm and temperate North Atlantic; Vancouver Island.

Several small tufts on Fort Macon jetty, Beaufort, N. C., June, 1907.

Two small masses of Callithamnion collected on Fort Macon jetty at the same time as the above may also be referred to this species or may be specimens of *C. tetragonum* (Wither.) Ag. Two other specimens from Fort Macon jetty, March, 1909, resemble *C. affine* Harv., but are immature and can not be determined with reasonable certainty. In addition to these, many small masses or fragments insufficient for determination have been found on Bogue Beach at different times.

Genus 4. **Spyridia** Harvey.

Spyridia, Harvey, in Hooker, 1833, p. 336.

Frond erect, usually terete, sometimes somewhat flattened, branching profuse, usually radial, sometimes somewhat distichous, frond beset with numerous more or less fine, hairlike, persistent or somewhat evanescent branchlets composed of single rows of cells, sometimes with layers of cortical cells encircling the nodes or covering the entire branchlet; structure cellular, with a central axis composed of a row of large cells and surrounded, for the most part, by a more or less dense cortex whose cells become smaller toward the surface; tetrasporangia occurring singly or in groups externally at the nodes of hairlike branchlets, triangularly divided; antheridia forming more or less expanded cylindrical patches inclosing portions of the hairlike branchlets; procarps terminal on short branches, bearing two opposite auxiliary cells; cystocarps terminal on short lateral branches, at first having two lobes, later forming three or more irregular lobes, pericarp rather thick, at first closed, later opening irregularly, gonimoblast divided into several lobes composed of dichotomous fastigiate filaments, forming carpospores from their upper segments, these spores appearing in tufts radiating from a placenta that is continuous with the stalk of the cystocarp and is prolonged almost to its apex.

About 17 species in warm and temperate seas.

KEY TO SPECIES.

Ultimate branches not markedly tapering toward the bases, not club-shaped. 1. *S. filamentosa* (p. 512).
Ultimate branches markedly tapering toward the bases, club-shaped.....2. *S. clavata* (p. 513).

1. **Spyridia filamentosa** (Wulfen) Harvey. Pl. CXI, fig. 1

Fucus filamentosus, Wulfen, 1803, p. 64.
Spyridia filamentosa, Harvey, in Hooker, 1833, p. 336.
Spyridia filamentosa, Harvey, 1853, p. 204.
Spyridia filamentosa, Farlow, 1882, p. 140, pl. 10, f. 1, pl. 12, f. 2.
Spyridia filamentosa, De Toni, 1903, p. 1427.
A. A. B. Ex. No. 151 a, b.
P. B.-A. Nos. 393, 1746, 1897.

Fronds moderately robust, terete, 4 to 25 cm. tall, about 1 mm. in diameter below, tapering toward the apices, branching radial, cortex continuous almost to the apices of the branches; branches sometimes recurved, hairlike branchlets more or less abundant, especially over the upper parts of the branches, about 0.5 to 1.5 mm. long, naked, except at the nodes, where they are surrounded by a ring of cortical cells, simple and acuminate at the apices; segments of the branches about equal to the diameter in length or somewhat longer, those of the hair branchlets 2 to 4 diameters long; tetrasporangia borne singly or two to three together at the nodes of the hairlike branchlets; cystocarps two to three lobed, terminal on short, lateral branches; texture flaccid or slightly rigid and brittle; color purplish pink.

Warm and temperate waters generally.

Small fragments in tide pool on "Town Marsh," Beaufort, N. C., September, 1905, two large masses on Bogue Beach, October, 1905, large, battered specimens in tide pool ("Mullet Pond") on Shackleford Banks, August, 1907, few plants dredged from coral reef offshore, August, 1914 and 1915. Abundant on *Zostera marina* in Pamlico Sound, 0 to 30 cm. below low water, August, 1907, Ocracoke, N. C. Few specimens on beach, August, 1909, Georgetown, S. C.

This species is distinguished from the following one by absence of the club-shaped branches and by the numerous fine, hairlike branchlets scattered over the frond and usually abundant on the younger parts of the branches. It is variable in appearance, but good specimens are usually easily recognized. It is not likely to be mistaken for any other species in this region.

2. **Spyridia clavata** Kuetzing.

Spyridia clavata, Kuetzing, 1841, p. 744.
Spyridia clavata, De Toni, 1903, p. 1435.

Fronds slender or moderately robust, rather terete below, flattened above, 8 to 20 cm. long, about 1 to 2 mm. wide, branching distichous, usually alternate, sometimes opposite, larger and smaller branches intermixed, cortex continuous to the apices of the branches; smaller branches tapering toward the bases, larger toward the apices, markedly club shaped, about 2 to 4.5 mm. long, apices acuminate or obtuse; very fine, hairlike branchlets present, but not very conspicuous, naked, except at the nodes, where they are surrounded by a ring of cortical cells, simple and acuminate at the apices; texture gelatinous-cartilaginous, somewhat rigid; color light pink with tinge of green or straw.

North Carolina; West Indies; Senegambia.

Several plants dredged from coral reef offshore, Beaufort, N. C., August, 1914.

This species is distinguished from the preceding by its markedly club-shaped, small branches and by the flattening present in the upper part of the frond. It sometimes resembles, in its gross appearance, *Chondria tenuissima*, but is easily distinguished from this by its evident segments showing through the cortex, resembling in this respect *Ceramium rubrum*.

This is the northern known limit of the species.

Genus 5. **Ceramium** Agardh.

Ceramium, Agardh, 1817, p. XXVI.

Frond erect, terete, slender, of moderate size, branching profuse, regularly dichotomous with forcipate apices, and bearing in addition more or less numerous lateral branches; structure cellular, with a central axis composed of a row of large cells and surrounded at the nodes or throughout by a more or less dense cortex whose cells become smaller toward the surface, sometimes beset with spinelike hairs; tetrasporangia formed from cortical cells at the nodes, naked or inclosed, often becoming prominent and protruding, occurring singly or several together, sometimes forming a single or double circle surrounding the node, triangularly divided; antheridia forming more or less expanded irregular patches over the surface of the cortex on smaller branches; procarps occurring in small numbers on the outer side of the upper dichotomies, bearing two carpogonia; cystocarps lateral, sessile at the nodes, toward the apices of the branches, sometimes appearing almost terminal, surrounded by several short, incurved branchlets, contain-

ing one or two gonimoblasts divided into several rounded lobes successively developed and forming numerous angular carpospores inclosed by a hyaline sack, pericarp lacking.

About 65 species, all marine, generally distributed.

The genus is easily recognized by the dichotomous frond consisting of a central row of large cells, with a cortical layer inclosing the nodes or extending over the entire thallus and usually with forcipate tips, but the species are often difficult of determination. Few species have been found in this region, and the two of these that are certainly determinable are usually easily recognized.

KEY TO SPECIES.

a. Cortex covering the entire frond ..... 2. *C. rubrum* (p. 514).
aa. Cortex confined to band surrounding each node, internodes naked ..... *b*.
b. Tetrasporangia occurring singly at the nodes in secund series or two to four together in a semicircle ..... 1. *C. tenuissimum* (p. 514).
bb. Tetrasporangia occurring in single circles surrounding the nodes ..... 3. *C. strictum* (p. 515).

1. **Ceramium tenuissimum** (Lyngbye) J. Agardh.

Ceramium diaphanum var. *tenuissimum*, Lyngbye, 1819, p. 120, pl. 37, B, f. 4.
Ceramium tenuissimum, J. Agardh, 1851, p. 120.
Ceramium tenuissimum, Harvey, 1853, p. 216.
Ceramium tenuissimum, Farlow, 1882, p. 138.
Ceramium tenuissimum, De Toni, 1903, p. 1450.
P. B.-A. Nos. 497, 798, 1298, 1898.

Frond capillary, of uniform diameter, forming more or less dense tufts usually 2 to 10 cm. high, regularly dichotomously decompound with short, lateral branches scattered here and there, branches erect, spreading, apices forcipate; lower segments 3 to 6 diameters long, nodes slightly swollen, cortex confined to a band surrounding each node and extending for a short distance over the internodes, remainder of internode naked; tetrasporangia occurring singly on the outer side of the upper nodes in secund series or, less often, two to four together forming more or less of a semicircle at the nodes, immersed in the cortical layer, often protruding and prominent; cystocarps lateral near the apices, surrounded by a few short, simple, incurved branches; texture slightly rigid; color purplish or reddish pink.

Temperate waters generally.

Occasional on other algæ, Bogue Beach, Beaufort, N. C., summer and autumn, fruiting.

Here are placed, with some doubt, several small, rather uncharacteristic specimens whose characters, as far as they are shown, seem to agree with this species. These are 0.5 to 3 cm. tall, and bear tetrasporangia usually singly, protruding, inclosed by a cellular covering. Both tetrasporangia and cystocarps are abundant, even on plants only 0.5 cm. tall. The characters of these specimens would, perhaps, agree equally well with those of *C. fastigiatum*, but it may be questioned if these two species are really distinct. With the exception of a single plant, all the specimens of Ceramium which have been found here during the summer and autumn may, perhaps, be referred to this species, but it is possible that some or all of these may be reduced summer forms of *C. strictum*.

2. **Ceramium rubrum** (Hudson) Agardh. Pl. CXI, fig. 2.

Conferva rubra, Hudson, 1762, p. XXVII.
Ceramium rubrum, Agardh, 1817, p. 60.
Ceramium rubrum, Harvey, 1853, p. 213.
Ceramium rubrum, Farlow, 1882, p. 135.
Ceramium rubrum, De Toni, 1903, p. 1476.
P. B.—A. Nos. 345, 646.

Frond robust, tapering toward the apices, 5 to 40 cm. tall, dichotomously decompound with short, sometimes numerous, lateral branches; branches subfastigiate or spreading, apices usually forcipate, nodes often contracted, lower segments 2 to 3 diameters long, cortex covering the entire frond, moderately thick below, thinner above, more or less obscuring the nodes; tetrasporangia immersed among the cortical cells at the nodes, forming one or two circles surrounding the nodes or occurring without order, rather prominent; cystocarps occurring singly or in pairs on the upper branches, surrounded by a few short, incurved branches; texture rather rigid; color dull reddish.

Cold and temperate North Atlantic and Pacific, reported on our coast as far south as Charleston, S. C. One specimen, Bogue Beach, Beaufort, N. C., April, 1908.

This species will not be mistaken for any other in our region, being easily recognized by the completely corticated fronds. Several varieties have been described.

3. **Ceramium strictum** Harvey. Pl. CXI, fig. 3.

Ceramium strictum, Harvey, 1849a, p. 163 (in part and excluding synonyms, not *Gongroceras strictum* Kuetzing).
Ceramium strictum, Farlow, 1882, p. 136.
Ceramium strictum, De Toni, 1903, p. 1484.
P. B.-A. Nos. 347, 846.

Frond capillary, tapering toward the apices, forming more or less dense tufts, usually 2 to 15 cm. tall, regularly dichotomously decompound with short lateral dichotomous branches scattered here and there; branches fastigiate, apices forcipate, lower segments 4 to 6 diameters long; cortex confined to a narrow band surrounding each node and extending a short distance over the internodes; remainder of internode naked; tetrasporangia occurring in single circles surrounding the nodes, immersed among the cortical cells; cystocarps lateral near the apices of branches, surrounded by a few rather elongated, simple, incurved branches; texture flaccid; color purplish pink.

Temperate North Atlantic; Mediterranean.

Beaufort, N. C.: Few specimens on Bogue Beach, February and March, 1909; very abundant throughout harbor and on Fort Macon and Shackleford jetties, 0 to 30 cm. below low water, April, 1908; fairly abundant throughout harbor and on jetties, May, 1907; on few specimens of *Gracilaria confervoides* from coral reef offshore, May, 1907; one specimen on Fort Macon jetty, July, 1908.

This species varies considerably in the diameter of the frond, the color, and the amount of branching, but good specimens will usually be easily recognized by the narrow bands of cortical cells and the single whorls of tetrasporangia around the nodes. It is the only species which has been observed growing here in the spring. The only species observed in this region with which it is likely to be confused is *C. tenuissimum* (?), from which it is distinguished by its whorls of tetrasporangia and often by its narrower bands of cortical cells. Typical specimens of these species will not be mistaken for each other, but as the tetrasporangia of *C. tenuissimum* are sometimes borne in more or less of a semicircle, and those of *C. strictum* sometimes form incomplete whorls, some specimens will give considerable trouble in their determination. In *C. strictum* the naked internodes are often more conspicuous than in *C. tenuissimum*, being strikingly evident to the naked eye.

This is the southern limit recorded for the species on our coast, but it probably extends farther south in the spring. In this region it seems to appear about February, reach its greatest development in April, and disappear about June, unless some of the small specimens found during the summer are stunted summer forms of this species.

Besides the specimens referred to above, minute, undeveloped plants, insufficient for reference to any species, are found occasionally on other algæ on Fort Macon jetty and on Bogue Beach.

Order 4. **Cryptonemiales.**

Cryptoneminæ, De Toni, 1905, p. 1523.

Carpogenic branches and auxiliary cells occurring separately in the thallus. The fertilized egg cell sends out through the tissue of the thallus more or less long, often branched filaments whose terminal or intercalary cells fuse with single auxiliary cells; thereupon these auxiliary cells develop gonimoblasts toward the surface or interior of the thallus, usually attached to a basal placenta; cystocarps usually immersed.

KEY TO FAMILIES.

Carpogonia and auxiliary cells formed on special secondary filaments, which develop branches forming upright, oval, or flask-shaped structures inclosing the reproductive cells, gonimoblast embedded in the thallus, forming several successive lobes ..... 1. GRATELOUPIACEÆ (p. 516).

Carpogonia and auxiliary cells numerous, formed at the base of special flask-shaped conceptacles in the thallus, usually closely associated, gonimoblasts numerous, usually arising from a cell formed by the fusion, after fertilization, of all the auxiliary cells ..... 2. CORALLINACEÆ (p. 522).

Family 1. GRATELOUPIACEÆ Schmitz.

Frond usually terete, sometimes angular, flattened or foliaceous, usually laterally, sometimes dichotomously, branched in various ways, nearly always showing a very evident filamentous structure; tetrasporangia scattered over the thallus or confined to special fertile portions, embedded in the cortex or in swollen nemathecia, cruciately divided; carpogonia and auxiliary cells formed on short, special branches of filaments in the inner part of the outer cortex, these branches giving off short lateral branches which inclose the carpogonium or auxiliary cell, forming upright oval or flask-shaped structures, auxiliary cells occurring singly, intercalary in the filamentous branches, branches forming auxiliary cells and, to a less extent, those forming carpogonia, developed in large numbers, intermingled; cystocarps usually small, scattered over the thallus or confined to special portions, usually many occurring near together, embedded in the inner cortex, forming very slight swellings on the surface, usually surrounded by a more or less developed network of filaments, communicating with the exterior by a pore, gonimoblast arising from the base on a more or less large stalk cell, divided into more or less numerous, compact, successively formed lobes, forming numerous carpospores in compact groups.

About 150 species, mostly in warm seas.

KEY TO GENERA.

a. Tetrasporangia formed in nemathecia, cortex parenchymatous, compact, frond foliose, borne on a short stalk ..... 3. Cryptonemia (p. 521).
aa. Tetrasporangia embedded in the outer cortex ..... *b*.
b. Thallus terete, angular, or flattened, cortex rather thin, small celled, and compact without, large celled and loose within, joining medullary portion by large, scattered, reticulately arranged cells, medullary portion consisting of a loose network of filaments ..... 1. Halymenia (p. 516).
bb. Thallus flattened, cortex rather thick, consisting of compact anticlinal rows of small cells without, looser within, gradually passing over into the medullary portion, medullary portion consisting of a rather compact network of filaments. . 2. Grateloupia (p. 520).

Genus 1. **Halymenia** Agardh.

Halymenia, Agardh, 1817, p. XIX.

Frond terete, angular, or flattened, dichotomously or laterally branched in various ways, often bearing proliferations from the margins; structure cellular filamentous, medullary portion consisting of a loose network of thin, segmented, branched filaments traversing the inner tube, cortex usually rather thin, small celled and compact without, large celled and lax within, joined to the medullary portion by large, scattered, reticulately arranged cells; tetrasporangia scattered over the frond, embedded in the outer cortex, cruciately divided; antheridia forming colorless patches over the surface of the thallus; cystocarps scattered over the frond, small, inconspicuous, embedded in the inner cortex, forming little or no swelling on the surface, inclosed by a more or less developed network of filaments, communicating with the exterior by a pore, bearing

numerous minute carpospores somewhat fasciculately radiating from a central point and tightly inclosed by gelatinous material.

About 25 species in warm seas.

KEY TO SPECIES.

a. Frond terete or slightly flattened, dichotomously branched.....1. *H. agardhii* (p. 517).
aa. Frond with broad, flattened, central axis and main branches and rather terete or slightly flattened secondary branches, laterally branched.....2. *H. floresia* (p. 518).
aaa. Frond flat, expanded, borne on a short stipe, simple or giving off several lobes from near the base, sometimes proliferous from the margins.....*b*.
b. Frond gelatinous-fleshy, moderately thick, surface appearing roughly papillate under microscope, many starlike ganglia plainly visible below surface.....3. *H. gelinaria* (p. 518).
bb. Frond firm membranaceous, thin, surface smooth, few starlike ganglia visible below surface, color purplish pink.....4. *H. floridana* (p. 519).

1. **Halymenia agardhii** De Toni. Pl. CXII, fig. 1.

Iszymenia flabellata, J. Agardh, 1899, p. 66.
Halymenia agardhii, De Toni, 1905, p. 1542.
A. A. B. Ex. No. 80 (*Halymenia decipiens*).
P. B.-A. No. 647 (*Halymenia decipiens*).

Frond terete or flattened, 5 to 20 cm. tall, 2 to 10 mm. in diameter, dichotomously decompound, often with a few short dichotomous proliferations, gradually tapering toward the apices, branches rather erect and spreading above, rounded sinuses, habit usually dense, fan-shaped, apices obtuse, inner filaments more or less abundant, intermixed with jelly, irregularly branched, anastomosing, segmented, forming more or less long, cylindrical, or short, somewhat rounded cells; tetrasporangia scattered over the surface among the cortical cells, inconspicuous; cystocarps immersed in the inner cortex, forming no swellings on the surface, appearing as small, inconspicuous dots scattered over the frond; texture rather gelatinous; color yellowish pink to dark, purplish pink.

Florida; West Indies; Bermuda.

Two fruiting plants dredged from coral reef offshore, Beaufort, N. C., August, 1915, occasional on Bogue Beach, summer and autumn, sometimes fruiting.

In typical specimens of this species the dichotomies are frequent, becoming more numerous toward the tips, forming a dense habit with the upper branches crowded, the apices are rounded, and the internal filaments are fairly numerous and usually of uniform diameter. But apparently there is considerable variation among authentic specimens in the size of the plants, the acuteness of the apices, and the amount of spreading of the ultimate branches.

The specimens here referred to this species vary in habit and somewhat in structure. In some the branching is profuse, forming the dense habit given as characteristic of the species, but in others this is distant, forming an open habit. The apices are sometimes rounded, but are more often acuminate, the same specimen sometimes having some branches rounded and others acuminate. The internal filaments may be fairly numerous, but are often sparse. While, therefore, some of the plants do not have all the characters given as typical for the species, authentic specimens themselves vary in these respects. It may be that, in the present case, two species are confused, but it has seemed impossible to separate the specimens into two groups. It has been mentioned that *Dictyota dichotoma*, growing under different conditions, may vary in the acuteness of the apices and may assume habits described for different forms and even different species. No study has yet been made of *H. agarhdii* in this respect, and we do not know enough of the influence of the environment on its form to warrant the separation of species on slight, variable differences in habit.

This species may easily be mistaken for members of other genera reported from Florida, and therefore liable to be cast on our coast. It closely resembles *Halarachnion ligulatum* (Woodw.) Kuetz. The latter species has a more generally open habit, more acute apices and fewer internal filaments than *Halymenia agardhii*, but, as has been mentioned, the latter species may itself vary in these respects. The essential distinction between these species can be made only by the characters of the genera, in that Halarachnion forms its auxiliary cells and cystocarps on the primary filaments, while Halymenia forms these on special secondary branches.

H. agardhii also bears a strong superficial resemblance to *Chrysymenia halymenioides* Harv. Fruiting specimens are easily distinguished, since in the latter species the cystocarps are large and prominent, forming conspicuous excrescences on the surface; sterile specimens may be readily distinguished by the structure, the frond of *C. halymeniodes* forming a delicate tube filled only with jelly, internal filaments being almost or entirely lacking, and the wall composed of only two or three layers of cells.

This is the northern limit of the species and of the genus.

2. Halymenia floresia (Clemente) Agardh. Pl. CXII, fig. 2.

Fucus floresius, Clemente, 1807, p. 312.
Halymenia floresia, Agardh, 1822, p. 209.
Halymenia floresia, Harvey, 1853, p. 193.
Halymenia floresia, De Toni, 1905, p. 1545.
P. B.-A. No. 298.

Frond flattened, 6 to 30 cm. tall, arising from a basal disk, supported on a stipe tapering into the frond, pinnately decompound, main axis flattened, 1 to 6 cm. wide, pinnæ flattened, pinnules somewhat flattened or rather terete, both long, linear, acuminate, spreading, margins of pinnæ and pinnules entire or beset with numerous teeth or cilia, inner filaments rather sparse and lax, intermixed with jelly, cortex consisting of one or two layers of cells; tetrasporangia occurring among the cortical cells, inconspicuous; cystocarps suspended within the cortex, inconspicuous, forming no swellings on the surface, appearing as minute dots scattered over the frond; texture gelatinous, delicate; color pinkish straw to bright rosy pink.

Warm North Atlantic; Mediterranean; Red Sea.

One fragment, Bogue Beach, Beaufort, N. C., September, 1904.

The battered fragment found at Beaufort is 12 cm. long, but does not include either the base or the apex. It resembles specimens of the species from other regions, except that it is less frequently branched. This species will not be mistaken for any other within our range.

This is the northern limit of the species and of the genus.

3. Halymenia gelinaria Collins and Howe. Fig. 44; Pl. CXII, figs. 3 and 4a.

Halymenia gelinaria, Collins and Howe, 1916, p. 173.
P. B.-A. Nos. 749 (*Halymenia floridana*), 750 (*Halymenia floridana* forma *dentata*), 2050.

Frond flat, about 5 to 60 cm. tall, 3 to 60 cm. wide, borne on a short, narrow, filiform, conspicuous stipe a few mm. long, suborbicular, oblong, ovate, or cuneate-obovate, subentire or rather sparingly parted, lobed, or proliferous, the margins entire or very irregularly cut in various ways; medulla traversed by few or many irregularly branched, conspicuously segmented filaments of different sizes, frequently anastomosing and occasionally forming structures resembling stellate ganglia, cortex one to four cells thick, outermost cells more or less vertically elongate, cuticle frequently dissolved, so that the surface appears papillate; tetrasporangia scattered among the superficial cells; cystocarps numerous, scattered, minute, often slightly protuberant on one surface; texture rather gelatinous; color light purplish pink to dark, purplish red, often with a tinge of greenish yellow.

Florida.

Occasional on Bogue Beach, Beaufort, N. C., summer and autumn, few small plants dredged from coral reef offshore, May, 1907, and July, 1915.

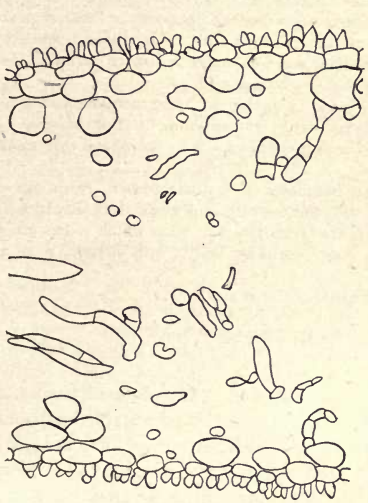
This species, placed in Herb. Agardh under *Halymenia floridana* and included in that species by previous authors, has been separated by Collins and Howe (1916), since it differs decidedly from the form that is generally recognized as the type of that species. It has a rather thick, gelatinous texture, the structure is decidely loose, the cortex consisting of usually one, sometimes two or more, layers of large, loose cells, from which project small, vertical, papillate cells, often not bounded by a definite cuticle; the medullary portion is usually not densely filled with jelly and is traversed by very scattered, irregularly branched, conspicuously segmented filaments of different sizes; anastomoses are often abundant and conspicuous toward the surface; in surface view the surface appears papillate; a subepidermal view seen from the surface shows numerous filaments of various sizes radiating from common centers and anastomosing, but forming a homogeneous part of the structure, heteromorphous "stellate ganglia" being rare; the color is light, purplish pink, to dark, purplish red, usually with a decided tint of greenish yellow.

This species is distinguished from *Halymenia floridana* by its thicker, more gelatinous texture, its looser structure, its papillate surface seen in surface view, its scarcity of heteromorphous "stellate ganglia" in subepidermal view, and its less rosy color, sometimes with a greenish or yellowish tinge. Its cystocarps also appear to the naked eye larger and less dense than in *H. floridana*. The two species may usually be distinguished with certainty, but one specimen (No. 22), having the structure of *Halymenia gelinaria* and accordingly placed in that species, has the color and texture of *Halymenia floridana*.

It is distinguished from *Chrysymenia agardhii*, which it resembles, by its more gelatinous texture, its slightly thinner frond, with smaller, less numerous cells, and by its conspicuously papillate surface.

The structure of the present species closely resembles that of the single specimen of *Halymenia latifolia* that has been available to the author.

This is the northern known limit of the species and of the genus.



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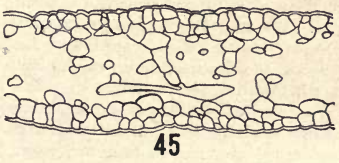

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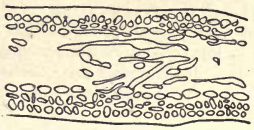

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FIG. 44.—*Halymenia gelinaria*, cross section of thallus (microtome section from preserved material), × 240.

FIG. 45.—*Halymenia floridana*, cross section of thallus (microtome section from dried material), × 240.

FIG. 46.—*Halymenia floridana*, cross section of thallus (hand section from dried material), × 240.

FIG. 47.—*Melobesia farinosa* f. *callithamnioides*, portion of thallus as seen in surface view, × 44.

4. Halymenia floridana J. Agardh. Figs. 45 and 46; Pl. CXII, fig. 4b.

Halymenia ligulata, Harvey, 1853, p. 192 (not *H. ligulata* of other authors).
Halymenia floridana, J. Agardh, 1894, p. 59.
Halarachnion? floridanum De Toni, 1905, p. 1655.
(Not P. B.-A. Nos. 749, 750.)

Frond flat, 5 to 20 cm. tall, 4 to 10 cm. wide, borne on a short, narrow, filiform, conspicuous stipe a few mm. long, at first ovate, entire, later forming numerous ovate lobes cuneate at the bases, tapering toward the obtuse apices, finally laciniate, somewhat palmatifid; medulla traversed by many irregularly branched filaments of irregular sizes, segmented occasionally, but not conspicuously, frequently anastomosing and forming numerous conspicuous stellate ganglia, cortex one to four cells thick, the cells usually of fairly uniform diameter, cuticle persistent and conspicuous, surface smooth; cystocarps occurring singly, appearing as minute dots scattered over the thallus, forming slight swellings on both surfaces; texture thin, membranaceous; color dark rose or purplish pink.

Florida; Bermuda.

Occasional on Bogue Beach, Beaufort, N. C., summer and autumn, sometimes fruiting.

Two distinct forms, a thin, membranaceous one and a thicker, more gelatinous one, have previously been included under this species. Although both these forms seem to be represented under the name "*Halymenia floridana*" in Herb. Agardh [a] the concensus of opinion seems to be that the thin form should be considered as the type, and the thick one has accordingly been separated by Collins and Howe (1916) under the name *Halymenia gelinaria*.

The present species (figs. 45 and 46) has a rather thin, membranaceous texture; the structure is fairly dense, the cortex consisting of one or usually two layers of medium-sized cells apparently formed from the ends of filaments, bounded by a definite cuticle; the medullary portion is densely filled with jelly and is traversed by rather scattered, irregularly branched filaments, segmented occasionally, but not conspicuously, the majority of these being small but mixed with occasional larger filaments, both kinds being irregular in size, anastomoses appear infrequent and inconspicuous in section; in surface view the surface appears composed of small, roundish-angular cells situated close together; a subepidermal view seen from the surface shows conspicuous anastomoses of filaments and numerous heteromorphous "stellate ganglia" apparently formed from the enlarged ends of the larger filaments, from which radiate filaments running parallel with the surface and frequently fusing with similar filaments from other similar ganglia; the color is rather dark, rose or purplish pink.

This species is distinguished from *Halymenia gelinaria* by its thinner, more membranaceous texture, its denser structure, its small cells seen in surface view, its heteromorphous "stellate ganglia" seen in subepidermal view, and its more rosy color. Its cystocarps also appear to the naked eye smaller and denser than in *H. gelinaria*.

From *Chrysymenia agardhii*, which it somewhat resembles, it is distinguished by its more membranaceous texture and its thinner, denser frond, with smaller cells and more numerous internal filaments. It is distinguished from *Callymenia reniformis* (Turn.) J. Ag., with which it has often been confused, by its thinner, more membranaceous, less gelatinous frond, with denser, more regular structure.

This is the northern known limit of the species and of the genus.

Genus 2. **Grateloupia** Agardh.

Grateloupia, Agardh, 1822, p. 221.

Frond flattened, dichotomously or laterally branched in the plane of the flattening, primary frond sometimes simple or irregularly divided, often irregularly proliferous from the margins and sometimes from the flat surfaces; structure filamentous, inner (medullary) layer composed of thin, segmented, reticulately anastomosing filaments, sometimes rather lax, inner cortex moderately thick, lax within, gradually passing over into the medullary portion, outer cortex rather thick, composed of vertical, moniliform filaments; tetrasporangia scattered over the frond, embedded in the outer cortex, cruciately divided; antheridia arising from the outer cortical cells, forming patches over the surface of the frond; cystocarps scattered over the frond or forming irregular groups, small, inconspicuous, entirely sunken within cavities in the cortical layer, communicating with the exterior by an opening formed among the cortical filaments, bearing numerous carpospores in irregular groups radiating from a central point.

About 35 species, mostly in warm seas.

KEY TO SPECIES.

Fronds decompound-pinnate, narrow linear, 0.5 to 2.5 mm. wide.....1. *G. filicina* (p. 521).
Fronds rather simple or irregularly divided, finally pinnate from the margins, main axis 0.5 to 4 cm. wide.....2. *G. gibbesii* (p. 521).

[a] The author is indebted to Dr. Marshall A. Howe for information regarding specimens placed under this species in Herb. Agardh.

1. **Grateloupia filicina** (Wulfen) Agardh. Pl. CXIII, fig. 1.

Fucus filicinus, Wulfen, 1789, p. 157, pl. 15, f. 2.
Grateloupia filicina, Agardh, 1822, p. 223.
Grateloupia filicina, Harvey, 1853, p. 200.
Grateloupia filicina, De Toni, 1905, p. 1563.
P. B.-A. Nos. 394, 1449.

Frond flattened, 4 to 45 cm. tall, 0.5 to 2.5 mm. wide, branching decompound-pinnate, sometimes irregular, sometimes bearing proliferations from the flat surfaces, main axes and pinnæ tapering toward the base and apices, linear; pinnæ about 0.3 to 2 mm. wide, lower ones usually longer and pinnulate, upper ones shorter and rather simple; tetrasporangia immersed in the pinnules, inconspicuous, sometimes clustered; cystocarps immersed in the pinnæ, numerous, clustered, inconspicuous; texture tough-membranaceous; color straw pink to reddish or greenish purple.

Warm and temperate waters generally.

One group on Fort Macon jetty, Beaufort, N. C., August, 1906, and July, 1908, 10 to 20 cm. below low water, some tetrasporic.

This species varies considerably in habit, ranging from one main axis with regularly distichous branches from the margins to many axes about equally prominent giving off branches about equal to the main axes; the branching is frequent or infrequent and sometimes is very irregular, with numerous small branches; the main axes are more or less flattened, sometimes being almost terete. In spite of its variability, it is not apt to be mistaken for any other species occurring within our range.

This is the northern known limit of the species and of the genus on our coast.

2. **Grateloupia gibbesii** Harvey. Pl. CXIII, fig. 2.

Grateloupia gibbesii, Harvey, 1853, p. 199, pl. 26.
Grateloupia gibbesii, De Toni, 1905, p. 1566.

Frond flattened, 6 to 60 cm. tall, 0.5 to 4 cm. wide, rather simple or irregularly divided, finally pinnate from the margins, sometimes bearing numerous proliferations from the flat surfaces, main axis and pinnæ tapering toward each end, pinnæ more or less elongated, narrow, linear-lanceolate, often bearing numerous small, narrow pinnules; cystocarps minute, densely scattered through the lobes, embedded in the cortical layer; texture fleshy-membranaceous; color blackish purple, changing to greenish purple.

Abundant on jetty directly exposed to sea, Charleston, S. C., from tops of rocks washed by waves to 15 cm. below low water, Morris Island, July, 1909.

This species is extremely various in habit, the fronds being simple or much divided in irregular ways; the margins and surfaces may be smooth or densely covered with proliferations. In spite of its variation, the species is easily recognized. It is not known beyond Charleston and vicinity.

Genus 3. **Cryptonemia** J. Agardh.

Cryptonemia, J. Agardh, 1842, p. 100.

Frond flat, stipitate, usually provided with a midrib often becoming less conspicuous toward the apices, simple or dichotomous or proliferous from the midrib or margin; structure fairly dense, medullary portion consisting of elongated, segmented, branched, densely interwoven filaments, cortex dense, composed of one or a few layers of large, rounded cells within, small cells without, disposed without definite order; tetrasporangia embedded among the cortical cells, occurring in locally thickened nemathecia borne on special, smaller, usually terminal shoots; cystocarps small, inconspicuous, usually borne on smaller, terminal portions of the thallus, either on special segments or scattered over the surface, communicating with the exterior by a pore, bearing numerous minute carpospores without regular order in a rounded mass suspended from the medullary filaments.

About 10 species, in warm seas.

Cryptonemia crenulata J. Agardh. Pl. CXIII, fig. 3.

Cryptonemia crenulata, J. Agardh, 1847, p. 11.
Cryptonemia crenulata, Harvey, 1853, p. 184.
Acrodiscus ? crenulatus, De Toni, 1905, p. 1599.
A. A. B. Ex. No. 23.
P. B.-A. Nos. 549, 2100.

Frond flattened, ruffled, 2 to 14 cm. tall, 0.5 to 5 cm. wide, supported on a short stipe, which soon passes over into the expanded portion of the thallus, branching dichotomous or almost palmatifid, often with similar expanded, dichotomous proliferations from the margins, margin sometimes entire, usually eroso-denticulate and slightly curled, segments linear or wedge-shaped, rounded, obtuse, or truncate at the apices; tetrasporangia occurring in rounded sori near the margins of the segments; cystocarps appearing as minute dots, scarcely visible to the naked eye, clustered here and there on the surface of the frond; texture membranaceous, rigid; color rosy purple, sometimes slightly greenish.

North Carolina to Brazil.

Occasional on Bogue Beach, Beaufort, N. C., August to October, sometimes bearing cystocarps.

This species was removed from the present genus by De Toni and doubtfully placed under Acrodiscus Zanard. with the note that, according to the suggestion of Schmitz, the latter genus should be united with Polyopes J. Ag. The structure of the cortex of this species is, however, parenchymatous, agreeing with that of *Cryptonemia lomation* (Bertol.) J. Ag., the type of the genus, and is not composed of anticlinal rows of cells, as in Acrodiscus and Polyopes. The species is accordingly retained under Cryptonemia.

This species is easily recognized by the crisp, ruffled frond, which is so rigid that it can be made to lie flat only by considerable pressure. Dried specimens, when moistened, show this character almost as clearly as do living plants.

This is the northern known limit of the species and of the genus.

Family 2. CORALLINACEÆ (Gray) Harvey.

Frond extremely various in form, filamentous, foliaceous, crustaceous, flattened, terete or irregular, simple or dichotomously, laterally or irregularly branched in various ways, sometimes endophytic, nearly always more or less strongly incrusted with lime, structure cellular-filamentous, nearly always compact; tetrasporangia (or sometimes disporangia) occurring in more or less well-defined sori embedded in the thallus, sometimes in definite, flask-shaped conceptacles scattered over the frond or borne in special, swollen portions, often mingled with sterile paraphyses, usually zonately divided, sometimes forming only two spores, communicating with the exterior by one or more pores; antheridia borne in flask-shaped conceptacles formed in the thallus and communicating with the exterior by a pore, scattered over the frond or borne in special swollen portions, forming spermatangia singly on long stalks or in chains, mingled with paraphyses; carpogonia and auxiliary cells numerous, usually borne together on upright, branched filaments arising from the base of flask-shaped conceptacles formed in the thallus and communicating with the exterior by a pore, scattered over the frond or borne in special swollen portions, gonimoblasts numerous, usually arising as single cells from the periphery of a large discoid cell in the base of the conceptacle, formed by the fusion, after fertilization, of all the auxiliary cells, cutting off chains of carpospores in basipetal succession, the numerous carpospores and parphyses finally filling the conceptacle.

Nearly 400 species, widely distributed, mostly in warm seas.

KEY TO GENERA.

a. Thallus consisting of a flat disk ..... *b*.
b. Thallus, thin, composed of a single undifferentiated layer ..... 1. Melobesia (p. 523).
bb. Thallus thick, composed of a thin lower layer and a thicker upper layer, tetrasporangia borne on the sides of the conceptacle ..... 2. Dermatolithon (p. 524).

aa. Thallus consisting of an irregularly spreading, calcareous mass incrusting stones, coral, or other algæ.....*c.*

c. Mature tetrasporangial conceptacle having a separate opening for each sporangium .....3. Lithothamnium (p. 524).

cc. Mature tetrasporangial conceptacle having a single opening through which all the sporangia discharge, vegetative tissues usually in fairly regular layers..4. Lithophyllum (p. 525).

aaa. Thallus erect, segmented, branched.....*d.*

d. Cystocarps forming wartlike protuberances, scattered over the surface of the segments.....5. Amphiroa (p. 526).

dd. Cystocarps immersed in the swollen apices of some segments.....6. Corallina (p. 527).

Genus 1. **Melobesia** Lamouroux.

Melobesia, Lamouroux, 1816, p. 313.

Thallus forming a small, flattened disk, attached to the substratum by the entire under surface, strongly incrusted with lime, composed of a single, undifferentiated stratum, consisting of numerous rows of cells disposed in a radiating, fanlike arrangement, with larger, more-elongated cells (so-called "hair cells" or "heterocysts") present among the ordinary cells; tetrasporangia zonately divided, borne in flask-shaped conceptacles formed by the separation of thallus cells, these conceptacles borne superficially or somewhat immersed in locally thickened portions, opening to the exterior by a single central pore, or by a separate pore situated above each tetrasporangium; antheridial and cystocarpic conceptacles flask-shaped, superficial or somewhat immersed, opening by single, central pores.

About 20 species, widely distributed, especially in warm seas.

The group of algæ including this and related genera has been differently arranged by different authors and has recently been extensively divided. There is at present little uniformity in the treatment of the forms included in this group, and it seems probable that further work will change the arrangement proposed by present authors.

Melobesia farinosa Lamouroux.

Melobesia farinosa, Lamouroux, 1816, p. 315.
Melobesia farinosa, Farlow, 1882, p. 180.
Melobesia farinosa, De Toni, 1905, p. 1764.
P. B.-A. Nos. 200, 1549.

Frond forming small, thin, flat, more or less rounded disks, 1 to 5 mm. in diameter, surface farinaceous, irregularly rimose from the center to the periphery, composed of a single stratum except in the vicinity of conceptacles; conceptacles scattered over the frond, 0.1 to 0.2 mm. in diameter, rather inconspicuous, opening by single central pores surrounded by elongated cells, but not conspicuously bordered by cilia.

Generally distributed in all seas.

Abundant on other algæ on Bogue Beach, Beaufort, N. C., abundant on *Sargassum filipendula* dredged from coral reef offshore, July to August, 1915, probably at other times also.

Forma **callithamnioides** (Falkenberg) Foslie. Fig. 47.

Melobesia callithamnioides, Falkenberg, 1879, p. 265.
Melobesia callithamnioides, De Toni, 1905, p. 1765.
Melobesia farinosa f. *callithamnioides*, Foslie, 1905, p. 96.

Fronds very variable, consisting of creeping, closely adherent, dichotomously branched filaments which are sometimes considerably elongated, often spreading out toward the apices and coalescent into more or less dense structures broken by more or less numerous interspaces, sometimes forming more or less complete dichotomously radiating disks, closely adherent by the entire lower surface; conceptacles of the same size as in the species, but rarer, the form being mostly sterile.

Naples; Adriatic Sea.

Fairly abundant on various algæ dredged from the coral reef offshore, Beaufort, N. C., August, 1914.

As found in Europe, the form grades over into the species, but in this region it seems, while approaching the habit of the species, to remain distinct.

This form has not previously been reported from North America.

Another species, *M. lejolisii* Rosanoff, a more northern species than the above, may be found within our range, but has not been observed by the author. This is distinguished from the present species by the absence of "heterocysts" in the frond and the presence of conspicuous cilia bordering the openings of the conceptacles.

The only other species recorded for this region that is likely to be mistaken for the above is *Dermatolithon pustulatum* (Lamour.) Foslie. The latter is distinguished by its thicker frond and larger, more conspicuous conceptacles.

Genus 2. **Dermatolithon** Foslie.

Dermatolithon, Foslie, 1900, p. 21.

Thallus forming a small, flattened disk, attached to the substratum by the entire under surface, strongly incrusted with lime, composed of two distinct strata, the lower, a thin hypothallium, usually consisting of a single layer of elongated cells, and the upper, a thicker perithallium, consisting of several layers of cells; tetraspongia borne in flask-shaped conceptacles somewhat immersed in locally thickened portions, each conceptacle opening to the exterior by an apical pore; sporangia borne only on the sides of the conceptacle, the middle being occupied by paraphyses; cystocarps borne in flask-shaped, somewhat immersed conceptacles opening by apical pores, carpospores accompanied by paraphyses.

About 10 species, generally distributed, especially in warm seas.

Dermatolithon pustulatum (Lamouroux) Foslie.

Melobesia pustulata, Lamouroux, 1816, p. 315, pl. 12, f. c, B.
Melobesia pustulata, Farlow, 1882, p. 181.
Dermatolithon pustulatum, Foslie, 1900, p. 21.
Dermatolithon pustulatum, De Toni, 1905, p. 1771.
P. B.-A. No. 300 (Melobesia farinosa).

Frond forming rather small, rather thick, flat, rather rounded more or less confluent disks, 2 to 10 mm. in diameter, surface not farinaceous, composed of two differentiated strata, hypothallium consisting of vertically elongate cells, perithallium consisting of rather square cells, "heterocysts" lacking; conceptacles large, conspicuous, 0.3 to 0.5 mm. in diameter, scattered over the thallus, opening by single, central pores, not bordered by cilia.

Widely distributed.

Very abundant on *Zostera marina* and often on other algæ throughout the harbor and on Bogue Beach, Beaufort, N. C.

This species often occurs in pure growths almost covering the leaves of Zostera. It is distinguished from *Melobesia farinosa*, the only other species observed here with which it is likely to be confused, by its thicker frond, its larger, more conspicuous conceptacles, and the absence of "heterocysts."

Genus 3. **Lithothamnium** Philippi.

Lithothamnium, Philippi, 1837, p. 387.

Thallus forming a more or less irregular incrusting mass, attached to the substratum by the entire under surface, frequently giving off from this base more or less numerous wartlike, stemlike, or corallike outgrowths of various, frequently irregular, shapes, strongly incrusted with lime, composed of two strata, cells more or less regularly arranged; tetrasporangia borne in superficial or somewhat sunken conceptacles, each sporangium opening to the exterior by a separate pore, sporangia zonately divided; antheridia and

cystocarps borne in more or less conical, superficial, or slightly sunken conceptacles, each conceptacle opening by a single apical pore, carpospores arising from the periphery of the fusion cell, the central part of the fusion cell bearing a few elongated, evanescent paraphyses; antheridia and cystocarps apparently borne on different plants.

About 80 species, widely distributed, mostly in warm seas.

This genus has been variously characterized by different authors and is still not well understood. It is distinguished from Lithophyllum chiefly by the fact that each sporangium communicates with the exterior by a separate pore, so that the surface of a mature tetrasporangial conceptacle, when viewed with a lens, looks like a miniature pepperbox. The species are exceedingly difficult and can be determined only by those who are familiar with them or by comparison with authentic specimens. In some cases the same species seems to show different forms on different substrata.

Lithothamnium sejunctum Foslie (?).

Lithothamnion sejunctum, Fosile, 1906, p. 3.

Thallus disk shaped, almost spherical, later confluent and irregular, rather thick, forming masses incrusting stones, etc., strongly calcified and closely attached to the substratum, showing slight, concentric zonation; composed of two distinct strata, the lower (hypothallium) composed of several layers of cells about 11 to 18 by 5 to 9 mic., the upper (perithallium) composed of several layers of cells, these cells squarish, 5 to 7 mic. in diameter or slightly vertically elongated, sometimes slightly horizontally elongated; tetrasporangial conceptacles embedded, hemispherical, 160 to 260 mic. in diameter, bearing about 40 pores; cystocarpic conceptacles hemisph ericalconical, 200 to 300 mic. in diameter.

West Indies.

Incrusting coral rock dredged from coral reef offshore, Beaufort, N. C., May, 1907 (?).

To this species is referred, with some doubt, an antheridial plant incrusting a part of one piece of coral rock, but the determination can not be made with assurance, since no authentic specimen has been available for comparison. It does not seem to belong to any other described species, and has not seemed to deserve description as a new species. It is probable that much of the coral rock dredged from the reef bears this plant, but only one piece has been available for examination. On this piece the plant here referred to occurs alongside *Lithophyllum intermedium*. From the latter species it is distinguished with difficulty. As found here, it has a slightly rougher, less glistening surface than the Lithophyllum. In section the two strata are more sharply defined than in the latter form. This species has not been recorded elsewhere outside of the West Indies.

Genus 4. **Lithophyllum** Philippi.

Lithophyllum, Philippi, 1837, p. 387.

Thallus forming a more or less irregular incrusting mass, more or less closely attached to the substratum, margin free or loosely attached, undivided or variously lobed, sometimes bearing irregular proliferations, strongly incrusted with lime, composed of two strata, cells rather regularly arranged, radiating toward the periphery, those in the upper perithallium smaller than in the lower hypothallium; tetrasporangia borne in sunken or somewhat prominent conceptacles, these conceptacles hemispherical-conical, at first convex, then losing more or less of the cortex, becoming somewhat depressed, the entire conceptacle communicating with the exterior by a single central pore; cystocarps borne in sunken or somewhat prominent, convex conceptacles, carpospores accompanied by a central mass of short paraphyses.

About 50 species, mostly in warm seas.

This genus has been variously characterized by different authors and is still not well understood. It is distinguished from Lithothamnium chiefly by the fact that the entire tetrasporangial conceptacle communicates with the exterior by a single apical

pore; in most cases, at least, the cells also are arranged in more regular layers than in Lithothamnium. The species are exceedingly difficult and can be determined only by those who are familiar with them or by comparison with authentic specimens.

Lithophyllum intermedium Foslie.

Lithophyllum intermedium, Foslie, 1906, p. 23.

Thallus disk shaped, almost spherical, later irregular, up to about 3 mm. thick, forming masses incrusting stones, etc., more or less closely attached by the under surface, bowl shaped or irregular, edges scalloped or irregular; showing two distinct strata, the lower (hypothallium) weakly or strongly developed, composed of several or many layers of cells 11 to 25 by 7 to 11 mic., the upper (perithallium) composed of several layers of cells almost always vertically elongated, 9 to 22 (usually 9 to 18) mic. long and 7 to 11 mic. broad; tetrasporangial conceptacles somewhat convex, not sharply defined, 150 to 250 or up to 300 mic. diameter.

Florida; West Indies.

Incrusting coral rock dredged from coral reef offshore, Beaufort, N. C., May, 1907, one small sterile plant on base of *Sargassum filipendula* dredged from coral reef, July, 1915.

This species will not be mistaken for any other found in this region except *Lithothamnium sejunctum* (?). From the latter it is distinguished with difficulty. As found here it has a slightly smoother, more glistening surface, and in section the two strata are less sharply defined than in the Lithothamnium. It is probable that much of the coral rock dredged from the reef bears this plant, but only one piece has been available for examination. On this it occurs alongside *Lithothamnium sejunctum* (?), and bears numerous tetrasporangial conceptacles. This is the northern known limit for the species and the genus.

Genus 5. **Amphiroa** Lamouroux.

Amphiroa, Lamouroux, 1812, p. 186.

Thallus erect, usually arising from a small basal disk, terete or more or less flattened, segmented, dichotomously, trichotomously, or verticillately branched, strongly calcified except at the more or less elongated joints; composed of elongated cells arranged in superimposed transverse zones surrounded, except at the joints, by a layer of smaller cortical cells; conceptacles small, scattered over the surface of the segments, immersed in the cortex or more or less prominent, opening by apical pores; tetrasporangia zonately divided.

About 30 species, in warm seas.

KEY TO SPECIES.

Segments of thallus terete or nearly so, frond strongly calcified and very brittle. 1. *A. fragilissima* (p. 526).
Segments of thallus decidedly flattened, often two or three times as broad as thick, frond less calcified and less brittle..... 2. *A. brasiliana* (p. 527).

1. **Amphiroa fragilissima** (Linnæus) Lamouroux. Pl. CXII, fig. 4c.

Corallina fragilissima, Linnæus, 1758, vol. 1, p. 806.
Amphiroa fragilissima, Lamouroux, 1816, p. 298.
Amphiroa fragilissima, De Toni, 1905, p. 1808.
P. B.-A. No. 2198.

Fronds forming tufts, 2 to 5 cm. tall, about 0.2 to 1 mm. in diameter, usually terete, sometimes flattened, especially toward the apices, branching dichotomous, sometimes irregular, segments 6 to 14 diameters long, usually 8 to 10 diameters, sometimes locally swollen; conceptacles scattered over the surface of the segments, inconspicuous; color pinkish white, becoming white when dried; texture very fragile.

West Indies; Peru.

Occasional on Bogue Beach, Beaufort, N. C., summer and autumn, 1903 to 1905; one plant Shackleford jetty, August, 1905; about 10 tufts, coral reef offshore, May, 1907.

The specimens from the coral reef and the plant from Shackleford jetty seem to agree with this species from other localities, except that they show slightly greater flattening. Some of the specimens

from Bogue Beach are decidedly coarser and wider, but the differences do not seem sufficiently great to warrant placing them in another species.

This species will not be confused with any other found in this region except *A. brasiliana*. From the latter it is distinguished by its more calcified, more brittle frond, with the segments terete or nearly so.

This is the northern known limit of the species and of the genus.

2. **Amphiroa brasiliana** Decaisne.

Amphiroa brasiliana, Decaisne, 1842 a, p. 125.
Amphiroa brasiliana, De Toni, 1905, p. 1817.

Frond forming tufts, 1 to 5 cm. tall, segments decidedly flattened, about 0.5 to 1.2 mm. wide, often two to three times as wide as thick, lower segments cuneate or quadrate, upper ones linear-obtuse; branching dichotomous; color dirty white; texture moderately fragile.

Brazil.

One fairly large tuft dredged from coral reef offshore, Beaufort, N. C., August, 1915.

The plants found here can not be determined with certainty because of the lack of authentic material for comparison. They seem, however, to belong to this species, judging from the descriptions and a photograph of the original material. This species is distinguished from the preceding by its less calcified, less brittle fronds, with decidedly flattened segments. It is not known elsewhere outside of Brazilian waters, unless this species is identical with some described under other names.

Genus 6. **Corallina** Linnæus.

Corallina, Linnæus, 1758, tom. 1, p. 805 (in part).

Thallus erect, usually arising from a small basal disk, terete or flattened, segmented, branching dichotomous or lateral, more or less abundant and usually in one plane, strongly calcified except at the more or less elongated joints; medullary portion more or less plainly transversely zonate, composed of compact, segmented, branched filaments, cortex composed of a few layers of small cells, becoming smaller toward the surface, cortex lacking at the joints; conceptacles occurring in the swollen apices of segments or filling the segments, sunken in the medullary layer, forming more or less prominent protuberances, opening by single apical pores; tetrasporangia zonately divided.

About 40 species, mostly in warm seas.

KEY TO SPECIES.

Frond 4 to 8 mm. tall, about 0.1 to 0.2 mm. in diameter, branching regularly dichotomous ..... 1. *C. capillacea* (p. 527).

Frond 1 to 2.5 cm. tall, about 0.2 to 0.7 mm. in diameter, branching partly pinnate, often bearing numerous opposite distichous branchlets ..... 2. *C. cubensis* (p. 528).

1. **Corallina capillacea** (Harvey) comb. nov. Pl. CXIV, fig. 6.

Jania capillacea, Harvey, 1853, p. 84.
P. B.-A. No. 150 (Jania capillacea).

Frond erect, capillary, about 4 to 8 mm. tall, 0.1 to 0.2 mm. in diameter, branching regularly dichotomous; conceptacles formed as flattened swellings at or near the ends of the ultimate branches, opening by a distinct apical pore; from the upper edges of these conceptacles there arise branches (usually two) as continuations of the frond; carpospores club shaped, arising in a compact group from base of conceptacle; tetrasporangia zonately divided, arising in a compact group from base of conceptacle.

Florida; West Indies; Bermuda.

One small mass on *Sargassum sp.*, Bogue Beach, Beaufort, N. C., August, 1903, two to three plants on coral reef offshore, May, 1907.

This species is easily distinguished from the following one by its smaller size, its more regularly dichotomous branching, and its production of hornlike branches from the upper edges of the conceptacles. It will not be mistaken for any other occurring in this region.

This is the northern known limit of the species.

2. **Corallina cubensis** (Montagne) Kuetzing. Pl. CXIII, figs. 4 and 5.

Jania cubensis, Montagne, in Kuetzing, 1849a, p. 709.
Jania cubensis, Harvey, 1853, p. 84.
Corallina cubensis, Kuetzing, 1858, Bd. 8, p. 37, pl. 77, f. II.
Jania cubensis, De Toni, 1905, p. 1857.
P. B.-A. No. 1500.

Frond erect, forming dense, intricate tufts, 1 to 2.5 cm. tall, about 0.2 to 0.7 mm. in diameter, branching dichotomous or subpinnate, branches spreading, sometimes naked, usually clothed with short, fine, simple, or sometimes forked branchlets arising oppositely in two rows, branchlets sometimes prolonged, segments of the frond subcylindrical below, more cuneate above; texture fragile; color dirty, whitish pink.

Florida; West Indies.

Few fairly large tufts dredged from the coral reef offshore, Beaufort, N. C., August, 1914, and July to August, 1915.

This species is easily distinguished from the preceding by its larger size, its more pinnate branching, and its opposite branchlets in two rows.

This is the northern known limit of the species.

Undetermined species.

A few species have been found in quantities or condition insufficient for determination. One of these (No. 1, Pl. CXII, fig. 5) seems deserving of comment. This is a red alga with an upright thallus, 6.5 cm. tall, shortly stipitate and attached by a small disk; it is flat and thin, being 4 to 13 mm. wide, irregularly branched and bearing minute proliferations from the margins and from the wider apices; the structure closely resembles that of *Halymenia floridana*, having the "stellate ganglia" in subepidermal view as found in that species; the texture is thin membranaceous, the color brownish red; no fruit is present. This specimen seems to be closely related to *Halymenia floridana*, but because of the difference in form and color and the absence of fruit, it has seemed best to keep it separate from that species.

SUMMARY OF ALGAL FLORA.

	Families.	Genera.	Species.	Varieties.	Per cent.	Identified species and varieties.	Per cent.
Myxophyceæ	5	10	12	.....	8.5	10	7.5
Chlorophyceæ	8	13	23	2	17.6	25	18.8
Phæophyceæ	8	18	27	2	20.4	27	20.3
Rhodophyceæ	12	43	74	2	53.5	71	53.4
Total	33	84	136	6	.....	133	.....

TABLES.

TABLE 1.—SPECIES FOUND IN BEAUFORT HARBOR.

Summer Flora:

MYXOPHYCEÆ—
- Chroococcus turgidus?
- Hydrocoleum lyngbyaceum.
- Lyngbya lutea.
- Oscillatoria nigro-viridis.

CHLOROPHYCEÆ—
- Ulva fasciata.
- Chætomorpha linum.
- Chætomorpha linum f. aerea.
- Chætomorpha brachygona.
- Cladophora crystallina.
- Codium decorticatum.
- Codium tomentosum.

PHÆOPHYCEÆ—
- Ectocarpus duchassaingianus.
- Ectocarpus mitchellæ.
- Rosenvingea orientalis.
- Dictyopteris polypodioides.
- Dictyota dichotoma.
- Padina vickersiæ.
- Spatoglossum schrœderi.

RHODOPHYCEÆ—
- Erythrotrichia carnea.
- Erythrocladia recondita.
- Goniotrichum alsidii.
- Acrochætium dufourii.
- Achrochætium hoytii.
- Acrochætium parvulum.
- Gelidium coerulescens.[a]
- Actinococcus aggregatus.
- Eucheuma gelidium.
- Gracilaria confervoides.
- Champia parvula.[a]
- Lomentaria uncinata.[a]
- Rhodymenia palmetta.
- Nitophyllum medium.
- Chondria dasyphylla.
- Chondria sedifolia.[a]
- Chondria atropurpurea?
- Herposiphonia tenella.
- Laurencia tuberculosa var. gemmifera.
- Polysiphonia harveyi.
- Polysiphonia denudata.
- Callithamnion polyspermum.
- Ceramium tenuissimum?
- Grateloupia filicina.
- Amphiroa fragilissima.
- Dermatolithon pustulatum.

Spring Flora:

CHLOROPHYCEÆ—
- Enteromorpha prolifera.
- Enteromorpha flexuosa.
- Enteromorpha intestinalis.
- Enteromorpha linza.
- Chætomorpha melagonium f. rupincola.
- Cladophora flexuosa.
- Rhizoclonium riparium.
- Bryopsis plumosa.

PHÆOPHYCEÆ—
- Ectocarpus confervoides.
- Ectocarpus siliculosus.
- Petalonia fascia.
- Leathesia difformis.
- Myrionema strangulans.
- Stilophora rhizodes.

RHODOPHYCEÆ—
- Bangia fusco-purpurea.
- Porphyra leucosticta.
- Acrochætium corymbiferum.
- Gelidium coerulescens.[b]
- Champia parvula.[b]
- Lomentaria uncinata.[b]
- Grinnellia americana.
- Chondria sedifolia.[b]
- Chondria tenuissima var. baileyana.
- Dasya pedicellata.
- Polysiphonia nigrescens.
- Ceramium strictum.

Perennial Species:

MYXOPHYCEÆ—
- Lyngybya confervoides?

CHLOROPHYCEÆ—
- Enteromorpha prolifera.
- Ulva lactuca (both varieties?).

PHÆOPHYCEÆ—
- Fucus vesiculosus.
- Sargassum filipendula.

RHODOPHYCEÆ—
- Acrochætium virgatulum.
- Gelidium crinale?
- Gymnogongrus griffithsiæ
- Agardhiella tenera.
- Gracilaria multipartita.
- Hypnea musciformis.

TABLE 2.—SPECIES FOUND ON CORAL REEF.

MYXOPHYCEÆ:
- Microchæte nana.[c]
- Phormidium sp.[c]

CHLOROPHYCEÆ:
- Cladophora sp.
- Derbesia turbinata.[c]
- Codium tomentosum.
- Udotea cyathiformis.[c]

PHÆOPHYCEÆ:
- Ectocarpus sp.
- Phæostroma pusillum.[c]
- Streblonema solitarium.[c]
- Elachistea stellulata.[c]
- Sporochnus pedunculatus.[d]
- Sargassum filipendula.
- Dictyopteris polypodioides.

[a] Occurs in the spring also. [b] Occurs in summer also. [c] Found growing in this region only on coral reef.

TABLE 2.—SPECIES FOUND ON CORAL REEF—Continued.

PHÆOPHYCEÆ—Continued.
- Dictyopteris serrata.[a]
- Dictyota dichotoma.
- Spatoglossum schrœderi.
- Zonaria flava.[a]

RHODOPHYCEÆ:
- Erythrocladia recondita.
- Erythrocladia vagabunda.[a]
- Goniotrichum alsidii.
- Acrochætium affine.[a]
- Acrochætium infestans.[a]
- Agardhiella tenera.
- Meristotheca duchassaingii.[a]
- Gracilaria confervoides.
- Hypnea muciformis.
- Champia parvula.
- Chrysymenia agardhii.[a]
- Chrysymenia enteromorpha.[a]
- Chrysymenia uvaria.[a]
- Lomentaria rosea.[a]
- Rhodymenia palmetta.
- Grinnellia americana.
- Nitophyllum medium.

RHODOPHYCEÆ—Continued.
- Brongniartella mucronata.[a]
- Chondria dasyphylla.
- Chondria sedifolia.
- Dasya pedicellata.
- Polysiphonia sp.
- Ceramium strictum.
- Callithamnion sp.
- Spermothamnion investiens.[a]
- Spyridia clavata.[a]
- Spyridia filamentosa.[a]
- Griffithsia sp.[a]
- Halymenia gelinaria.[a]
- Halymenia agardhii.[a]
- Amphiroa fragilissima.
- Amphiroa brasiliana.[a]
- Corallina capillacea.[a]
- Corallina cubensis.[a]
- Melobesia farinosa.[a]
- Melobesia farinosa f. callithamnioides.[a]
- Lithothamnium sejunctum (?).[a]
- Lithophyllum intermedium.[a]

TABLE 3.—SPECIES FOUND AT BEAUFORT ONLY ON BOGUE BEACH.

MYXOPHYCEÆ:
- Dichothrix penicillata.

CHLOROPHYCEÆ:
- Cladophora prolifera.
- Endoderma viride.
- Caulerpa prolifera.

PHÆOPHYCEÆ:
- Streblonema invisibile.
- Castagnea zosteræ.
- Sargassum natans.
- Sargassum natans f. angustum.
- Sargassum filipendula var. montagnei.
- Sargassum sp.
- Zonaria variegata.

RHODOPHYCEÆ:
- Rhabdonia ramosissima.
- Agardhinula browneæ.
- Chondria littoralis.
- Chondria sp.
- Laurencia sp.
- Polysiphonia havanensis.
- Ceramium rubrum.
- Cryptonemia crenulata.
- Halymenia floresia.
- Halymenia floridana.
- Undetermined species No. 1.

TABLE 4.—SPECIES FOUND ONLY AT PLACES OTHER THAN BEAUFORT.

OCRACOKE, N. C.:
- Lyngbya semiplena.
- Microcoleus chthonoplastes.
- Plectonema battersii.
- Spirulina sp.
- Ulvella lens.
- Gomontia polyrhiza.

SOUTHPORT, N. C.:
- Cladophora fascicularis.
- Bostrychia rivularis.

CHARLESTON, S. C.:
- Grateloupia gibbesii.

PORT ROYAL, S. C.:
- Gracilaria multipartita var. angustissima.

TABLE 5.—SPECIES REACHING IN THIS REGION THEIR NORTHERN KNOWN LIMIT ON OUR COAST.

Beaufort, N. C.:

HARBOR; SUMMER FLORA—
- Ulva fasciata.
- Chætomorpha brachygona.
- Codium decorticatum.[b]
- Codium tomentosum.[b]
- Ectocarpus duchassaingianus.
- Rosenvingea orientalis.[b]
- Dictyota dichotoma.[b]
- Padina vickersiæ.[b]
- Spatoglossum schrœderi.[b]
- Gelidium cœrulescens.
- Rhodymenia palmetta.
- Chondria atropurpurea.

Beaufort, N. C.—Continued.

HARBOR: SUMMER FLORA—Continued.
- Herposiphonia tenella.[b]
- Laurencia tuberculosa var. gemmifera.[b]
- Grateloupia filicina.[b]
- Amphiroa fragilissima.[b]

CORAL REEF—
- Udotea cyathiformis.[b]
- Zonaria flava.[b]
- Meristotheca duchassaingii.[b]
- Chrysymenia agardhii.[b]
- Chrysymenia enteromorpha.[b]
- Chrysymenia uvaria.[b]
- Brongniartella mucronata.[b]

[a] Found growing in this region only on coral reef.

[b] Northern known limit of genus on our coast.

TABLE 5.—SPECIES REACHING IN THIS REGION THEIR NORTHERN KNOWN LIMIT ON OUR COAST—Con.

Beaufort, N. C.—Continued.
CORAL REEF—Continued.
Spyridia clavata.
Spermothamnion investiens.
Halymenia gelinaria.[a]
Halymenia agardhii.[a]
Amphiroa brasiliana.[a]
Lithothamnium sejunctum (?).[a]
Lithophyllum intermedium.[a]
Corallina capillacea.
Corallina cubensis.
BOGUE BEACH—
Dichothrix penicillata.
Caulerpa prolifera.[a]
Castagnea zosteræ.
Zonaria variegata.[a]

Beaufort, N. C.—Continued.
BOGUE BEACH—Continued.
Rhabdonia ramosissima.[a]
Agardhinula browneæ.[a]
Chondria littoralis.
Polysiphonia havanensis.
Cryptonemia crenulata.[a]
Halymenia floresia.[a]
Halymenia floridana.[a]
Other localities:
SOUTHPORT, N. C.—
Cladophora fascicularis.
OCRACOKE, N. C.—
Eucheuma gelidium.[a]
CHARLESTON, S. C.—
Grateloupia gibbesii.

TABLE 6.—SPECIES REACHING IN THIS REGION THEIR SOUTHERN KNOWN LIMIT ON OUR COAST.

Beaufort, N. C.:
HARBOR—
Spring flora—
Chætomorpha melagonium f. rupincola.
Leathesia difformis.[b]
Stilophora rhizodes.[b]
Chondria tenuissima var. baileyana.
Ceramium strictum.
Summer flora—
Polysiphonia harveyi.[c]

Beaufort, N. C.—Continued.
HARBOR—Continued.
Perennial species—
Fucus vesiculosus.[b]
CORAL REEF—
Lomentaria rosea.
Ocracoke, N. C.:
Plectonema battersii.

TABLE 7.—SPECIES NEW TO NORTH AMERICA.

Beaufort, N. C.:
HARBOR—
Dictyopteris polypodioides.[a]
Erythrocladia recondita.[d]
Acrochætium dufourii.[d]
Acrochætium hoytii.[d]
Acrochætium parvulum.
Nitophyllum medium.[a, d]
CORAL REEF—
Microchæte nana.[d]
Derbesia turbinata.[d]
Phæostroma pusillum.[d]
Streblonema solitarium.
Elachistea stellulata.[b]
Sporochnus pedunculatus.[a]

Beaufort, N. C.—Continued.
CORAL REEF—Continued.
Dictyopteris polypodioides.[a]
Dictyopteris serrata.[a]
Erythrocladia recondita.[d]
Erythrocladia vagabunda.[d]
Acrochætium affine.[d]
Acrochætium infestans.[d]
Nitophyllum medium.[a, d]
Melobesia farinosa f. callithamnioides.
Amphiroa brasiliana(?).
BOGUE BEACH—
Streblonema invisibile.[d]
Ocracoke, N. C.:
Ulvella lens.

[a] Northern known limit of genus on our coast.
[b] Southern known limit of genus on our coast.
[c] Possibly at Port Royal, S. C.
[d] Species first described from this region.

TABLE 8.—DISTRIBUTION OF BEAUFORT AND ADJACENT SPECIES IN VARIOUS REGIONS.[a]

[Occurrence indicated by cross (X).]

	Northern New England.	Southern New England.	Florida-West Indies region.	Europe.	Pacific coast of North America.
MYXOPHYCEÆ.					
Chroococcus turgidus	X	X	X	X	X
Lyngbya confervoides	.....	X	X	X	X
Lyngbya semiplena	X	X	X	.....	X
Lyngbya lutea	X	X	X	X	.....
Oscillatoria nigro-viridis	X	.....	.....	.....	X
Hydrocoleum lyngbyaceum	X	X	X	X	X
Microcoleus chthonoplastes	X	X	X	X	X
Microchæte nana	.....	.....	.....	.....	.....
Plectonema battersii	.....	.....	X	X	.....
Dichothrix pencillata	.....	.....	X	X	.....
CHLOROPHYCEÆ.					
Ulva fasciata	.....	.....	X	X	X
Ulva lactuca var. rigida	X	X	X	X	X
Ulva lactuca var. latissima	X	X	X	X	X
Enteromorpha linza	X	X	.....	X	X
Enteromorpha prolifera	X	X	X	X	X
Enteromorpha intestinalis	X	X	X	X	X
Enteromorpha flexuosa	.....	.....	X	X	X
Endoderma viride	.....	.....	X	X	.....
Ulvella lens	.....	.....	X	X	.....
Chætomorpha brachygona	.....	.....	X	.....	.....
Chætomorpha linum	X	X	X	X	X?
Chætomorpha linum f. aerea	X	X	X	X	X
Chætomorpha melagonium f. rupincola	X	X	.....	.....	X
Rhizoclonium riparium	X	X	X	X	X
Cladophora flexuosa	X	X	.....	X	X?
Cladophora crystallina	.....	.....	X	X	.....
Cladophora fascicularis	.....	.....	X	X	.....
Cladophora prolifera	.....	.....	X	X	X
Gomontia polyrhiza	X	X	X	X	X
Bryopsis plumosa	X	X	X	X	X?
Derbesia turbinata	.....	.....	.....	.....	.....
Codium tomentosum	.....	.....	X	X	.....
Codium decorticatum	.....	.....	X	X	.....
Udotea cyathiformis	.....	.....	X	.....	.....
Caulerpa prolifera	.....	.....	X	X	.....
PHÆOPHYCEÆ.					
Ectocarpus mitchellæ	.....	X	X	X	X
Ectocarpus duchassaingianus	.....	.....	X	.....	.....
Ectocarpus siliculosus	X	X	.....	X	X
Ectocarpus confervoides	X	X	.....	X	X
Streblonema invisibile	.....	.....	.....	.....	.....
Streblonema solitarium	.....	.....	.....	X	.....
Phæostroma pusillum	.....	.....	.....	.....	.....
Petalonia fascia	X	X	.....	X	X
Rosenvingea orientalis	.....	.....	X	X	X
Elachistea stellulata	.....	.....	.....	X	.....
Castagnea zosteræ	.....	.....	X	X	.....
Myrionema strangulans	X	X	.....	X	X
Leathesia difformis	X	X	.....	X	X
Stilophora rhizodes	.....	X	.....	X	.....
Sporochnus pedunculatus	.....	.....	.....	X	.....
Fucus vesiculosus	X	X	.....	X	.....
Sargassum natans	.....	X	X	.....	.....
Sargassum natans f. angustum	.....	X	X	.....	.....
Sargassum filipendula	.....	X	X	.....	.....
Sargassum filipendula var. montagnei	.....	X	X	.....	.....
Zonaria flava	.....	.....	X	X	.....
Zonaria variegata	.....	.....	X	.....	.....
Padina vickersiæ	.....	.....	X	X	.....
Spatoglossum schroederi	.....	.....	X	.....	.....
Dictyopteris polypodioides	.....	.....	.....	X	.....
Dictyopteris serrata	.....	.....	.....	.....	.....
Dictyota dichotoma	.....	.....	X	X	.....
RHODOPHYCEÆ.					
Erythrocladia recondita	.....	.....	.....	.....	.....
Erythrocladia vagabunda	.....	.....	.....	.....	.....
Bangia fusco-purpurea	X	.....	X	X	X
Goniotrichum alsidii	.....	X	X	X	.....
Erythrotrichia carnea	X	X	X	X	.....

	Northern New England.	Southern New England.	Florida-West Indies region.	Europe.	Pacific coast of North America.
RHODOPHYCEÆ—continued.					
Porphyra leucosticta	.....	X	X	X	X
Acrochætium infestans	.....	.....	.....	.....	.....
Acrochætium parvulum	.....	.....	.....	X	.....
Acrochætium dufourii	.....	.....	.....	.....	.....
Acrochætium hoytii	.....	.....	.....	.....	.....
Acrochætium affine	.....	.....	.....	.....	.....
Acrochætium virgatulum	X	X	.....	X	.....
Acrochætium corymbiferum	.....	.....	.....	X	X
Gelidium coerulescens	.....	.....	X	.....	.....
Gelidium crinale	X	X	X	X	X
Gymnogongrus griffithsiæ	.....	X	.....	X	.....
Actinococcus aggregatus	.....	X	.....	X	.....
Agardhiella tenera	X	X	X	.....	X
Rhabdonia ramosissima	.....	.....	X	.....	.....
Eucheuma gelidium	.....	.....	X	.....	.....
Meristotheca duchassaingii	.....	.....	X	.....	.....
Gracilaria confervoides	.....	X	X	X	X
Gracilaria multipartita	.....	X	X	X	.....
Gracilaria multipartita var. angustissima	X	X	X	X	.....
Hypnea musciformis	.....	X	X	X	.....
Rhodymenia palmetta	.....	.....	X	X	.....
Agardhinula brownea	.....	.....	X	.....	.....
Chrysymenia enteromorpha	.....	.....	X	.....	.....
Chrysymenia agardhii	.....	.....	X	.....	.....
Chrysymenia uvaria	.....	.....	X	X	.....
Champia parvula	X	X	X	X	.....
Lomentaria uncinata	X	X	X	X	.....
Lomentaria rosea	X	X	.....	.....	.....
Nitophyllum medium	.....	.....	.....	.....	.....
Grinnellia americana	X	X	X	.....	.....
Laurencia tuberculosa var. gemmifera	.....	.....	X	.....	.....
Chondria dasyphylla	.....	X	X	X	.....
Chondria littoralis	.....	.....	X	.....	.....
Chondria atropurpurea ?	.....	.....	X	.....	.....
Chondria sedifolia	.....	X	X	.....	.....
Chondria tenuissima var. baileyana	X	X	.....	.....	.....
Polysiphonia harveyi	X	X	.....	.....	.....
Polysiphonia denudata	X	X	.....	X	.....
Polysiphonia havanensis	.....	.....	X	.....	.....
Polysiphonia nigrescens	X	X	.....	X	.....
Herposiphonia tenella	.....	.....	X	X	.....
Dasya pedicellata	X	X	X	X	.....
Bronginartella mucronata	.....	.....	X	.....	.....
Bostrychia rivularis	.....	X	X	.....	.....
Spermothamnion investiens	.....	.....	X	.....	.....
Callithamnion polyspermum	.....	.....	X	X	X
Spyridia filamentosa	X	X	X	X	X
Spyridia clavata	.....	.....	X	.....	.....
Ceramium rubrum	X	X	.....	X	X?
Ceramium strictum	X	X	X	X	.....
Ceramium tenuissimum	X	X	X	X	X
Halymenia floresia	.....	.....	X	X	X?
Halymenia agardhii	.....	.....	X	.....	.....
Halymenia gelinaria	.....	.....	X	.....	.....
Halymenia floridana	.....	.....	X	.....	.....
Grateloupia filicina	.....	.....	X	X	.....
Grateloupia gibbesii	.....	.....	X	.....	.....
Cryptonemia crenulata	.....	.....	X	.....	.....
Amphiroa fragilissima	.....	.....	X	.....	.....
Amphiroa brasiliana	.....	.....	X	.....	.....
Lithothamnium sejunctum ?	.....	.....	X	.....	.....
Lithophyllum intermedium	.....	.....	X	.....	.....
Corallina capillacea	.....	.....	X	.....	.....
Corallina cubensis	.....	.....	X	.....	.....
Melobesia farinosa	X	X	X	X	.....
Melobesia farinosa f. callithamnioides	.....	.....	.....	X	.....
Dermatolithon pustulatum	X	X	X	X	X
Total	45	61	93	78	41

[a] The data for this table were obtained from the distribution of the various species given by De Toni (1889–1907); from the lists of Collins for New England (1900), Jamaica (1901), and Vancouver Island (1913), of Hauck for Porto Rico (1888 a), of Börgesen for the Virgin Islands (Danish West Indies) (1913–1919), of Setchell and Gardner for northwestern America (1903), and of Saunders for Alaska (1901); and from information kindly furnished by Mr. Frank S. Collins and Dr. Marshall A. Howe.

TABLE 9.—SURFACE TEMPERATURE OF WATER AT 5 P. M. OFF LABORATORY WHARF, BEAUFORT, N. C.

[Expressed in degrees centigrade.]

Month.	1907			1908			1909		
	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.
January				12.0	5.0	9.0	15.5	7.8	11.0
February				12.8	3.9	8.5	16.7	5.5	11.0
March				19.5	10.0	14.5	16.0	10.0	13.3
April				21.7	16.0	19.0	22.8	13.9	16.7
May				26.7	18.9	23.3	25.5	18.3	22.0
June				28.3	24.5	26.7	29.5	23.9	26.7
July				31.0	25.0	28.5	31.0	25.5	27.0
August				28.9	23.0	27.5	30.0	25.5	27.8
September				26.0	20.0	23.5	27.8	17.8	24.7
October	18.3	14.4	[a] 16.5	22.0	14.5	18.9	23.9	15.5	[a] 20.5
November	16.0	10.5	13.3	18.9	11.7	15.0			
December	13.3	6.0	10.5	17.0	9.5	12.0			

Month.	1912			1913			1914		
	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.
January							15.0	5.0	9.4
February							14.0	3.0	9.4
March							16.0	3.0	9.8
April							23.0	12.0	16.8
May							26.0	18.0	22.0
June	29.5	20.0	25.4	28.0	17.0	21.0	30.0	22.0	26.1
July	30.0	26.0	28.0	30.0	26.0	27.8	30.0	25.0	28.0
August	28.9	23.9	27.0	30.0	26.0	27.8			
September	28.9	20.5	26.3	28.0	22.0	24.6			
October	24.4	16.0	20.0	25.0	14.0	19.9			
November	20.0	7.8	13.6	16.0	9.0	13.6			
December	16.7	7.0	11.5	14.0	7.0	10.5			

[a] Record available for only part of month.

ARTIFICIAL KEY TO GENERA.

A. Color bluish green or blackish, sometimes grayish green or tinted with other colors; single celled or composed of rather short filaments; attached or floating; forming small tufts or rather gelatinous, feltlike masses over considerable areas of the substratum. . I. MYXOPHYCEÆ.

a. Plants unicellular, cells living singly or a few associated in small ill-defined families ..... CHROOCOCCUS (p. 408).

aa. Plants multicellular, filamentous ..... *b.*

b. Filaments tapering at apices into multicellular hairs ..... DICHOTHRIX (p. 416).

bb. Filaments not tapering to hairs at apices ..... *c.*

c. Filaments unbranched ..... *d.*

d. Filaments lacking sheath ..... *e.*

e. Filaments, multicellular, elongated, straight or curved at the apices, not spirally twisted ..... OSCILLATORIA (p. 410).

ee. Filaments unicellular, short, twisted into a regular, more or less lax spiral ..... SPIRULINA (p. 411).

dd. Filaments with sheath ..... *f.*

f. Filaments possessing heterocysts ..... MICROCHÆTE (p. 414).

ff. Filaments lacking heterocysts ..... *g.*

g. Filaments composed of several trichomes in each sheath ..... MICROCOLEUS (p. 413).

gg. Filaments composed of single trichomes in separate sheaths ..... *h.*

h. Filaments about 1 mic. diameter ..... PHORMIDIUM (p. 411).

hh. Filaments more than 1 mic. in diameter ..... LYNGBYA (p. 411).

cc. Filaments branched ..... *i.*
i. Filaments lacking heterocysts ..... HYDROCOLEUM (p. 413).
ii. Filaments possessing heterocysts ..... PLECTONEMA (p. 415).
AA. Color green; filamentous or forming tubes or sheets or complex structures of various shapes composed of closely interwoven filaments; usually attached, sometimes floating; some forms minute, living on or in shells or other algæ; some forms incrusted with lime ..... II. CHLOROPHYCEÆ.
a. Frond flat, expanded ..... *b.*
b. Outline irregular, indefinite, usually floating, attached when young ..... ULVA (p. 420).
bb. Outline regular, definite; usually attached ..... *Enteromorpha linza* (p. 420).
aa. Frond forming a hollow tube ..... *c.*
c. Wall of tube composed of cells ..... ENTEROMORPHA (p. 418).
cc. Wall of tube not cellular, tube consisting of single unsegmented cavity of various complicated forms ..... *d.*
d. Frond consisting of an upright stalk arising directly from the base, pinnately branched above ..... BRYOPSIS (p. 431).
dd. Frond consisting of a creeping stem attached at intervals, from which arise erect branches of various forms ..... CAULERPA (p. 434).
aaa. Frond filamentous ..... *e.*
e. Frond microscopic, invisible to naked eye or visible only as a green stain on the substratum ..... *f.*
f. Frond living in walls of other algæ ..... ENDODERMA (p. 423).
ff. Frond living *on* surface of shells ..... ULVELLA (p. 423).
fff. Frond living *within* surface of shells ..... GOMONTIA (p. 429).
ee. Frond easily visible to naked eye ..... *g.*
g. Filaments unsegmented, loosely interwoven to form an irregular mat ..... DERBESIA (p. 430).
gg. Filaments segmented at regular intervals ..... *h.*
h. Filaments unbranched ..... CHÆTOMORPHA (p. 424).
hh. Filaments regularly branched; attached or floating ..... CLADOPHORA (p. 427).
hhh. Filaments usually with few irregular, rhizoidlike branches, sometimes unbranched, usually not attached ..... RHIZOCLONIUM (p. 427).
aaaa. Frond composed of branched filaments closely interwoven to form a complex structure ..... *i.*
i. Frond fan shaped on an evident stalk, incrusted with lime ..... UDOTEA (p. 433).
ii. Frond terete or somewhat flattened, dichotomously branched, spongy, not incrusted with lime ..... CODIUM (p. 432).
AAA. Color brown, sometimes with greenish tinge; filamentous or forming complex structures of various shapes; usually attached; some forms minute, living on or in other algæ ..... III. PHÆOPHYCEÆ.
a. Frond filamentous ..... *b.*
b. Frond easily visible to naked eye ..... ECTOCARPUS (p. 437).
bb. Frond microscopic, almost or quite invisible to naked eye ..... *c.*
c. Frond growing *on* the surface of other algæ ..... *d.*
d. Frond more or less spherical in outline, composed of decumbent radiating filaments united to form a basal layer from which arise erect filaments. MYRIONEMA (p. 445).
dd. Frond having no regular outline, composed of decumbent, irregularly dichotomous filaments ..... PHÆOSTROMA (p. 442).
cc. Frond growing *within* the surface of other algæ ..... *e.*
e. Frond forming its fruits above the surface in more or less spherical, dense clusters ..... ELACHISTEA (p. 444).
ee. Frond forming its fruits above the surface singly or in irregular, loose groups ..... STREBLONEMA (p. 440).
aa. Frond, small globose, hollow ..... LEATHESIA (p. 447).
aaa. Frond mostly terete, with distinct central axis and lateral branches ..... *f.*
f. Frond with many lateral branches leaflike, giving the appearance of stem and leaves, usually with berrylike floats ..... SARGASSUM (p. 451).

ff. Frond with ultimate branchlets club shaped and terminated by brushlike tufts of hairs, no floats present.....SPOROCHNUS (p. 448).
aaaa. Frond terete throughout, variously branched.....*g.*
g. Frond forming a hollow tube, constricted and twisted at irregular intervals, about 2 mm. in diameter, dichotomously branched.....ROSENVINGEA (p. 443).
gg. Frond not conspicuously tubular, about 1 mm. in diameter, irregularly branched, spongy texture.....CASTAGNEA (p. 446).
ggg. Frond solid or nearly so, less than 1 mm. in diameter, dichotomously branched.....STILOPHORA (p. 448).
aaaaa. Frond more or less flattened, simple or branched.....*h.*
h. Frond consisting of one or more elongated, leaflike lobes.....PETALONIA (p. 443).
hh. Frond fan shaped throughout or at least in the terminal segments.....*i.*
i. Frond or segments bearing concentric zones parallel with the apical margins, apical margins inrolled.....PADINA (p. 455).
ii. Frond or segments bearing radial markings running from the base to the apical margins, apical margins not inrolled.....ZONARIA (p. 454).
hhh. Frond dichotomously branched.....*j.*
j. Frond tough, leathery, usually with bladderlike floats at intervals in frond .....FUCUS (p. 450).
jj. Frond membranaceous, no floats present.....*k.*
k. Distinct midrib present.....DICTYOPTERIS (p. 459).
kk. No midrib present.....*l.*
l. Frond growing in length by group of initial cells, edges more or less serrate or dentate.....SPATOGLOSSUM (p. 458).
ll. Frond growing in length by single apical cell, edges with occasional proliferations but not serrate or dentate.....DICTYOTA (p. 460).
AAAA. Color various shades of red, pink, purple, sometimes blackish, yellowish, or green (if green, structure apparently cellular, not entirely composed of interwoven filaments), sometimes white from incrustations of lime; filamentous or forming sheets or complex structures of various shapes; some forms epiphytic, some minute, parasitic on other algæ; usually attached.....IV. RHODOPHYCEÆ.
a. Frond not incrusted with lime.....*b.*
b. Frond minute, parasitic, forming swollen knots on *Gymnogongrus griffithsiæ*.ACTINOCOCCUS (p. 477).
bb. Frond filamentous.....*c.*
c. Filaments creeping, closely adherent, forming irregular patches.....ERYTHROCLADIA (p. 466).
cc. Filaments more or less erect.....*d.*
d. Filaments regularly dichotomous, tips usually incurved.....CERAMIUM (p. 513).
dd. Filaments not regularly dichotomous.....*e.*
e. Filaments consisting throughout, or for the most part, of a single row of cells; simple or branched.....*f.*
f. Filaments sparse, scattered or few occurring in small tufts on other algæ; almost microscopic in size; slight branching by method known as "false branching".....GONIOTRICHUM (p. 465).
ff. Filaments composed of obovate or barrel-shaped cells.....GRIFFITHSIA (p. 511).
fff. Filaments densely branched, forming erect, fairly conspicuous tufts on rocks or plants.....CALLITHAMNION (p. 511).
ffff. Filaments growing in hydroids.....*Acrochætium infestans* (p. 473).
fffff. Filaments forming more or less dense mats over other algæ.....*g.*
g. Mat very fine, velvety, often inconspicuous except for the reddish tinge given the host; filaments minute.....ACROCHÆTIUM (p. 469).
gg. Mat coarser, conspicuous.....*h.*
h. Individual filaments easily discernbile, rather coarse; mat dark red, rather loose.....ERYTHROTRICHIA (p. 466).
hh. Individual filaments scarcely discernible, rather fine, velvety; mat bright red, dense.....SPERMOTHAMNION (p. 510).

ee. Filaments at first consisting of single rows of cells, the upper cells of the filaments soon divided longitudinally, forming tubes; unbranched...BANGIA (p. 464).
eee. Filaments consisting throughout of several rows of cells.....*i.*
i. Frond erect throughout, branching in all directions.....POLYSIPHONIA (p. 502).
ii. Frond erect, arising from a creeping filament, branching alternately pinnate, distichous, giving a zigzag appearance.....BOSTRYCHIA (p. 506).
iii. Frond creeping, forming a velvety mat with erect branches.....HERPOSIPHONIA (p. 507).
bbb. Frond terete, at least for the most part.....*j.*
j. Frond regularly dichotomous.....*k.*
k. Frond small, about 3 cm. long and less than 1 mm. in diameter; horny, tough; dark greenish purple.....GYMNOGONGRUS (p. 477).
kk. Frond large, 10 to 20 cm. long, 3 to 8 mm. in diameter; fleshy, soft; pink .....*Halymenia agardhii* (p. 517).
kkk. Frond large, 9 to 34 cm. long, 1 to 4 mm. wide, sometimes flattened, sometimes with pinnate branches in addition to dichotomies; cartilaginous, tough, coarse; red to purple and dark green.....*Gracilaria multipartia* (p. 484).
kkkk. Frond large, 8 to 18 cm. long, 0.5 to 1 mm. in diameter; many pinnate branches in addition to dichotomies; ultimate branches beset with numerous fine hairs along their sides; red.....*l.*
l. Hairs simple.....SPYRIDIA (p. 512).
ll. Hairs branched.....BRONGNIARTELLA (p. 505).
jj. Frond not regularly dichotomous.....*m.*
m. Frond consisting of a solid stem and ultimate hollow, bladderlike branches .....*Chrysymenia uvaria* (p. 491).
mm. Frond hollow, tubular.....*n.*
n. Frond large, up to 30 cm. long and 4 to 5 mm. in diameter; branches constricted at the bases.....*Chrysymenia enteromorpha* (p. 490).
nn. Frond 1.5 to 6 cm. long, about 1 mm. in diameter; constricted at intervals, the tube containing transverse diaphragms at these constrictions..CHAMPIA (p. 492).
nnn. Frond 1 to 3 cm. long, less than 1 mm. diameter; no transverse diaphragms; branches frequently arched and bearing branchlets principally along convex side; arched branches sometimes attached at their tips....LOMENTARIA (p. 491).
mmm. Frond solid or nearly so.....*o.*
o. Frond small, 1 to 5 cm. long, 0.5 mm. or less diameter; upright branches arising from a creeping stem.....GELIDIUM (p. 475).
oo. Frond larger than above.....*p.*
p. Branches beset with numerous hairs along their sides; red.....DASYA (p. 508).
pp. Ultimate branchlets constricted at the bases; red or reddish.....CHONDRIA (p. 498).
ppp. Branches recurved at the apices or bearing short, pointed, spinelike branchlets; green.....HYPNEA (p. 485).
pppp. Frond not distinguished by any of above characters.....*q.*
q. Branches arising on stem in two rows, main axis somewhat flattened.....*r.*
r. Texture somewhat gelatinous; branching pinnate throughout; cystocarps internal.....RHABDONIA (p. 480).
rr. Texture somewhat cartilaginous; branching partly dichotomous; cystocarps external, conspicuous.....*Gracilaria multipartita* (p. 484).
qq. Branches arising on all sides or at least not in two rows, main axis not flattened.....*s.*
s. Cystocarps internal.....*t.*
t. Texture rather gelatinous, soft.....AGARDHIELLA (p. 478).
tt. Texture rather cartilaginous, rigid.....EUCHEUMA (p. 481).
ss. Cystocarps external.....*u.*
u. Texture fleshy-cartilaginous; frond slender, usually not more than 1 mm. in diameter, beset with many short fine branch lets, smaller branches long, slender.....*Gracilaria confervoides* (p. 483).

uu. Texture rather cartilaginous; frond coarse, 1 to 1.5 mm. in diameter, sparingly branched, small branches few, usually coarse ..... *Gracilaria multipartita* (p. 484).

uuu. Texture cartilaginous, wiry; frond coarse, densely branched, branches interwoven, beset with many short, coarse, blunt branchlets ..... LAURENCIA (p. 497).

bbbb. Frond flattened ..... *v.*

v. Frond 1 to 25 mm. wide in widest part ..... *w.*

w. Frond regularly dichotomous ..... *x.*

x. Frond 4 to 12 mm. wide in widest part, 2 to 8 cm. long, membranaceous, fleshy, rather thick, edges smooth; red or pink ..... RHODYMENIA (p. 487).

xx. Frond 12 to 25 mm. wide in widest part, 3 to 10 cm. long, fleshy, rather coarse, edges ruffled; purple ..... CRYPTONEMIA (p. 521).

xxx. Frond 10 to 25 mm. wide in widest part, 6 to 20 cm. long, thin membranaceous, veined, edges wavy, slightly proliferous; bright pink ..... NITOPHYLLUM (p. 494).

ww. Frond pinnately or irregularly branched ..... *y.*

y. Frond not more than 1 mm. wide, fleshy, rather densely pinnately or irregularly branched; dark purple ..... *Grateloupia filicina* (p. 521).

yy. Frond 6 to 18 mm. wide in widest part, fleshy, main axis conspicuously larger than branches, densely decompound distichously branched, branches sometimes dichotomous, all branches flat, numerous branchlets frequently arising from the flat surfaces; purplish green ..... *Grateloupia gibbesii* (p. 521).

yyy. Frond 9 to 15 mm. wide in widest part, gelatinous, main axis conspicuously larger than branches, sparingly distichously branched, ultimate branches rounded; pink ..... *Halymenia floresia* (p. 518).

vv. Frond 40 to 130 mm. wide in widest part ..... *z.*

z. Frond very thin membranaceous, delicate ..... *a'.*

a'. Frond pink, simple or sparingly branched, bearing a conspicuous midrib and sometimes fine pinnate veins; fruit appearing as conspicuous dots on surface ..... GRINNELLIA (p. 495).

aa'. Frond purple, simple or irregularly divided into lobes, structure uniform; fruit not visible to naked eye ..... PORPHYRA (p. 464).

zz. Frond firm, membranaceous or fleshy ..... *b'.*

b'. Frond dichotomously branched ..... AGARDHINULA (p. 488).

bb'. Frond simple or lobate, not dichotomous ..... *c'.*

c'. Frond fleshy-cartilaginous, coarse, simple, or irregularly divided into lobes not reaching to the base, sometimes proliferous from the margins, stem inconspicuous; cystocarpic fruit borne in conspicuous, short protuberances arising from edges and surface; usually dark red, sometimes yellowish ..... MERISTOTHECA (p. 479).

cc'. Frond firm membranaceous, thin, usually divided into several more or less regular ovate or elliptical lobes arising from the base on distinct stalks; fruit in inconspicuous dots on surface; purplish pink ..... *Halymenia floridana* (p. 519).

ccc'. Frond gelatinous-fleshy, light pink, sometimes with yellowish tinge ..... *d'.*

d'. Frond simple or divided into several lobes borne on distinct stalks; frond or lobes ovate ..... *Halymenia gelinaria* (p. 518).

dd'. Frond simple or irregularly divided into lobes; frond or lobes lanceolate ..... *Chrysymenia agardhii* (p. 490).

aa. Frond incrusted with lime ..... *e'.*

e'. Frond erect, filiform, jointed ..... *f'.*

f'. Conceptacles immersed, scattered over the segments ..... AMPHIROA (p. 526).

ff'. Conceptacles immersed in the apices of terminal segments, opening by terminal pores, the fertile segments sometimes bearing hornlike lateral branches. CORALLINA (p. 527).

ee'. Frond horizontally expanded forming small, more or less definite, disk-shaped spots on the substratum.....*g'*.

g'. Frond thin, consisting of a single uniform layer; larger cells present among ordinary cells; conceptacles small.....MELOBESIA (p. 523).

gg'. Frond fairly thick, differentiated into a thin basal layer and a thicker upper one; cells of fairly uniform size; conceptacles large.....DERMATOLITHON (p. 524).

eee'. Frond forming indefinite expansions over the substratum.....*h'*.

h'. Tetrasporangial conceptacles opening by a separate pore for each sporangium .....LITHOTHAMNIUM (p. 524).

hh'. Tetrasporangial conceptacle opening by a single apical pore.....LITHOPHYLLUM (p. 525).

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GLOSSARY.

Acuminate, tapering gradually to a point.
Acute, having a distinct point, but not greatly elongated.
Adherent, attached more or less closely.
Adnate, attached by growth, grown together.
Æruginous, the blue-green color of verdigris.
Aggregated, massed together.
Akinete, a nonsexual reproductive cell formed by the massing of the contents of a vegetative cell, the wall of the mother cell thickening and functioning as the wall of the akinete.
Alternate, placed on opposite sides of a stem at different levels.
Anastomose, to run together and fuse into more or less of a network.
Anastomosis, the union of filaments or tubes with each other.
Ancipitate, two edged, flattened or compressed.
Antheridium (pl. *antheridia*), the organ forming male cells.
Anticlinal, perpendicular to the surface.
Apical, at or near the apex or tip.
Apiculum, a short, sharp point.
Aplanospore, a nonsexual reproductive cell formed by the massing of the contents of a vegetative cell and the formation about this of a new cell wall.
Approximate, situated close together, but not united.
Arcuate, curved like a bow.
Articulation, the joint of a more or less segmented structure.
Assimilating filaments, filaments borne on the surface, containing chlorophyll (and, usually, other pigments), and carrying on the process of photosynthesis, used especially in the Phæophyceæ to distinguish from superficial, colorless filaments.
Attenuate, attenuated, narrow and tapering.
Austral, southern, usually referring to the Southern Hemisphere.
Auxiliary cell, a cell in the Florideæ receiving a nucleus from the fertilized egg and, as a result of this, forming reproductive spores.
Axial, relating to the axis.
Axil, the distal (more apical) angle between the axis and an organ arising from it.
Axillary, growing in an axil.
Axis, the line running the length of a plant around which the branches are borne.

Biciliate, possessing two cilia.
Bipartite, divided into two parts.
Boreal, northern, usually referring to the Northern Hemisphere.
Brood bud, a specialized multicellular structure formed from a vegetative portion of a plant and serving for propagation.

Cæspitose, growing in tufts.
Calcified, containing a deposit of lime.
Callus, an abnormally thickened part, usually as a result of a wound.
Calyptra, a cap, used for the thickening of the outer wall of the apical cell of some Myxophyceæ.
Calyptrate, bearing a calyptra.
Capillary, slender, like a hair.
Capitate, used in the Myxophyceæ for the termination of a filament in a more or less globose head.
Carpogenic branch, a short, specialized, usually 3 or 4 celled, filamentous branch, occurring in the Florideæ, often immersed in the thallus, and bearing at its apex the female organ, carpogonium.
Carpogonium, the female organ of the Rhodophyceæ, consisting, in the Florideæ, of a swollen basal portion within which the egg is borne, and a hairlike, apical prolongation, the trichogyne.
Carpospore, a spore formed in the Rhodophyceæ as a result of the fertilization of the carpogonium.
Carpostome, the opening in the sterile jacket inclosing the carpospores of many Florideæ, through which the carpospores are shed.
Cartilaginous, hard and tough, having the texture of cartilage.
Caulescent, possessing a stalk.
Cellulose, a carbohydrate forming the principal constituent of young and unaltered cell walls; e. g., in the cotton of commerce.
Chlorophyll, the green coloring matter of plants.
Chromatophore, a body within a plant cell specialized to contain pigment.
Cilium (pl., *cilia*), a short, whiplike projection of a motile cell by means of which the cell propels itself; a minute outgrowth from a plant.
Clavate, club shaped, thickened toward the apex.
Claviform, club shaped.
cm., abbreviation for centimeter, about two-fifths of an inch.

Coalescent, becoming united by growth.
Compacted, closely packed or pressed together.
Conceptacle, a superficial cavity opening to the surface, within which reproductive organs are developed.
Confervoid, composed of unbranched filaments, threadlike.
Confluent, blended into one.
Conglobate, collected into a ball.
Conic, conical, cone shaped.
Constricted, narrowed, contracted.
Copulation, the union of sexual cells or organs.
Coriaceous, leathery.
Cortex, the tissue of a more or less solid alga lying beneath the epidermis, between this and the central region, medulla; when no epidermis is present, the outer region of the thallus surrounding the medulla.
Cortical, belonging to or occurring in the cortex.
Corticated, provided with a cortex.
Corymb, a flat-topped or convex cluster with the younger parts toward the middle.
Corymbose, occurring in corymbs.
Crateriform, cup shaped.
Crenate, scalloped, provided with rounded, wavy teeth or notches.
Cruciate, a method of division of a tetrasporangium by walls at right angles to each other, all of the four resulting tetraspores being visible in one plane, grouped around a common center.
Crustaceous, the thallus consisting of a relatively thin layer closely adherent to the substratum and of brittle texture.
Cryptostoma (pl., *crypstostomata*), a small cavity sunk in the thallus and bearing only hairs (paraphyses), found in the Fucaceæ.
Cuneate, wedge shaped.
Cuticle, the structureless layer bounding the outer surface of many plants.
Cyathiform, shaped like a wineglass.
Cylindric, elongated with a circular cross section.
Cymose, occurring in a more or less broad, flat-topped cluster, with the younger parts toward the periphery.
Cystocarp, a fruit produced as a result of the fertilization of the egg in the carpogonium, including the mass of carpospores, the accessory structures, and the inclosing, cellular, protective structures, found in many of the Florideæ.
Cystocarpic, bearing cystocarps, used to designate the female plant.

Decompound, divided several times.
Decumbent, reclining, but with the apex ascending.
Dentate, provided with sharp, toothlike structures.
Dichotomous, a method of branching by forking into two parts of approximately equal size.
Dichotomy, a forking into two parts.
Diffluent, becoming separate.
Diœcious, bearing male and female organs on separate plants.
Discoid, disklike, having a flat, rounded shape.
Discrete, separate, not coalescent.
Disporangium (pl., *disporangia*), a sporangium whose contents are divided into two spores.
Dissepiment, a partition.
Distichous, having the parts borne in two vertical rows, usually from the edges of a more or less flattened structure.
Divaricate, extremely spreading.
dm., abbreviation for decimeter, about 4 inches.
Dorsal, referring to the upper, or back, surface of a dorsiventral structure.
Dorsiventral, having unlike surfaces corresponding to back and front or upper and lower.

Ectosarc, the horny outer covering of hydroids.
Ellipsoid, having an elliptical shape.
Elliptical, oblong with regularly rounded ends.
Endochrome, the coloring matter contained within cells.
Endophytic, growing within the tissue of another plant.
Epidermal, belonging to the epidermis.
Epidermis, a definite, differentiated layer of cells bounding the outer surface of a plant.
Epiphytic, growing on another plant, using the host only for attachment, and not obtaining material from it.
Eroso-denticulate, having minute, irregular, marginal teeth, the margin being so irregular as to appear gnawed or bitten.
Excentric, out of the center, one-sided.
Exserted, protruding beyond the surface.

False branching, a type of branching in which a cell in the midst of a filament elongates and, pushing to one side, continues the growth in a new direction, found principally in the Myxophyceæ.
Farinaceous, rough and scaly in appearance.
Fascicle, a close cluster of stems or branches.
Fascicled, fasciculate, borne in a fasciclelike manner.
Fastigiate, the occurrence of stems or branches in erect, parallel clusters.
Fenestrate, pierced with holes.
Filamentous, threadlike.
Filiform, long, with a circular cross section.
Fistulose, hollow throughout its length.
Flabellate, fan shaped.
Flabellum, a fan-shaped structure.
Flaccid, limp, not rigid.

Flagelliform, like the lash of a whip.
Flexuous, flexible, easily bent; bent alternately in different directions.
Floccose, occurring in small, soft tufts or masses.
Foliaceous, flat and expanded like a leaf.
Forcipate, forked, with the apices approaching each other, like a pair of forceps.
Fragmentation, a breaking into pieces.
Fructification, fruiting, the bearing of organs of propagation or reproduction.
Fucoxanthin, a brown pigment found in some of the Phæophyceæ.
Furcate, forked, with terminal lobes like prongs.
Fusiform, spindle shaped, thick in the middle and tapering toward each end.
Fusoid, somewhat fusiform.

Gametangium (pl., *gametangia*), an organ bearing gametes.
Gamete, a sexual cell.
Ganglion (pl., *ganglia*), an enlargement caused by the fusion of separate filaments, or an enlarged portion of a filamentous structure from which smaller filaments radiate.
Glaucous, covered with a bloom, as on the fruit of the plum.
Globose, nearly spherical.
Glomerulus (pl., *glomeruli*), a roundish cluster of organs closely grouped into a common structure.
Gonidangium (pl., *gonidangia*), a specialized cell bearing gonidia.
Gonidium (pl., *gonidia*), a cell formed nonsexually and slightly specialized for propagation.
Gonimoblast, a cluster of filaments formed as a result of the fertilization of the egg in a carpogonium, some of whose cells become changed into carpospores, found in the Florideæ.
Gonimolobe, one of the lobes into which the gonimoblast may be divided.

Hermaphroditic, bearing male and female organs on the same individual.
Heterocyst, a more or less specialized cell which differs in appearance from the other cells, used in the Myxophyceæ for large cells occurring within the filaments and serving to break these apart; used in Melobesia for isolated large cells of unknown function.
Heterogametes, sexual cells in which the members of the fusing pairs differ from each other.
Heteromorphous, having a different shape.
Hormogonium (pl., *hormogonia*), a multicellular portion of a filament, becoming separate and serving for propagation, found in the Myxophyceæ.
Hyaline, colorless or translucent.
Hydranth, one of the individuals in a hydroid colony.
Hymenium, a network of more or less coalescent filaments forming a surface on which fruits are borne, a fruiting surface.
Hypothallium, the ventral (lower) portion of a flat thallus that is differentiated into two regions.

Incised, cut sharply into the margin.
Indusium, a sterile outgrowth of a thallus or structure covering fruiting organs.
Integument, the outer covering of an organ or body.
Intercalary, situated at some place between the apex and the base.
Intercellular, between the cells.
Internode, the space between two nodes.
Interpilar, between the rows of hairs.
Intricate, entangled.
Isogametes, sexual cells in which the members of the fusing pairs are similar.

Lacerate, appearing torn, or irregularly cleft.
Laciniate, cut into narrow lobes.
Lamellose, made up of thin plates joined into a common structure.
Lamina, the flattened portion of a leaflike structure.
Lanceolate, narrow, and tapering toward each end.
Linear, narrow, several times longer than wide.
Lobate, divided into or bearing lobes.
Lobe, a division of an organ or thallus.

Medulla, the central tissue of a more or less solid alga.
Medullary, situated in or belonging to the medulla.
Mic., abbreviation for micron, the unit of microscopic measure, the one-thousandth part of a millimeter.
Midrib, a thickened portion running midway along a flattened thallus.
mm., abbreviation for millimeter, about one twenty-fifth of an inch.
Moniliform, like a string of beads.
Monociliate, having a single cilium.
Monœcious, bearing male and female organs on the same plant.
Monopodial, a method of branching in which there is a distinct main stem running to the tip and lateral branches of smaller size than the central axis.
Monosiphonous, consisting of a single row of cells.
Monosporangium, a sporangium whose entire contents are formed into a single spore.
Monospore, a spore formed in a monosporangium.
Monostromatic, consisting of a single layer of cells.
Moriform, shaped like a mulberry.
Mucronate, possessing a short, straight point.

Multicellular, consisting of more than one cell.
Multifid, divided many times into lobes or segments.
Multinucleate, containing more than one nucleus.

Nematheciform, shaped like a nemathecium.
Nemathecium (pl. *nemathecia*) a wartlike elevation of the surface containing organs of reproduction.
Node, a joint in a distinctly segmented stem.
Nodule, a small knot, or thickened, dense structure.
Nucleus, a differentiated portion of the living material contained, usually, near the center of each cell; the central mass in the sexually formed fruit of some Florideæ.

Obconi-obovoid, obovate, but more narrowed at the narrower (basal) end.
Obdeltoid, shaped like the Greek capital letter delta, but reversed, with the narrower part toward the base.
Oblong, longer than broad, with nearly parallel sides.
Obovate, reversed ovate, with narrower end toward the base.
Obtuse, blunt or rounded at the end.
Oogonium (pl. *oogonia*), a single-celled female organ bearing one or more eggs.
Orbicular, flat with a circular outline.
Ovate, ovoid, egg shaped.

Palmate, divided into lobes arising from a common base, like the fingers from a hand.
Palmatifid, divided in a palmate manner almost to the base.
Paniculate, having the branches or parts arranged in a loose cluster.
Papilla, a small, short, superficial outgrowth.
Papillate, bearing papillæ.
Paraphysis (pl. *paraphyses*), a sterile filament projecting, usually, from the surface of many algæ, usually borne in clusters, frequently with the fruiting organs.
Parasitic, living on or in another plant or animal and obtaining nourishment from it.
Parenchymatous, consisting of loose tissue, composed of thin-walled cells of fairly uniform diameter in every direction, and often with conspicuous intercellular spaces.
Parietal, situated toward the wall, away from the center.
Parthenogenetically, applied to a method of development in which an egg develops without fertilization.
Patent, spreading.
Pectinate, pinnately divided into narrow segments or branches set close together like the teeth of a comb.
Pedicel, a short stalk bearing a specialized organ.
Pedicellate, borne on a pedicel.
Peduncle, a stalk bearing an organ or a group of organs, larger than a pedicel.
Penicillate, shaped like a pencil.
Perforate, pierced through, forming a hole.
Pericarp, the differentiated, sterile, cellular, protective structure inclosing the carpospores and accessory structures in many Florideæ.
Pericentral, applied to structures grouped around a common center or axis.
Peripheral, toward the circumference.
Perithallium, the dorsal (upper) portion of a flat thallus which is differentiated into two regions.
Petiole, the stem of a leaflike structure.
Phycoerythrin, a red pigment occurring in the Rhodophyceæ.
Piliferous, bearing hairs.
Pinna (pl. *pinnæ*), one of the divisions of a pinnately divided structure.
Pinnate, having branches or parts on opposite sides of a common stem or axis, as in a feather.
Pinnulate, applied to a structure which has pinnæ pinnately divided, twice pinnate.
Pinnule, one of the secondary divisions of a pinnulately divided structure.
Placenta, a more or less conspicuous structure serving as the place of origin and attachment for the gonimoblasts in the sporocarp of many Florideæ.
Plumose, featherlike or plumelike.
Plurilocular, a term used for the reproductive organs of many Phæophyceæ which are divided by walls into numerous compartments, producing a single motile reproductive cell in each compartment.
Polychotomous, a method of branching in which the thallus is divided into many parts of more or less equal size.
Polygonal, having many angles and many sides.
Polysiphonous, consisting of several coherent longitudinal rows of cells.
Polyspores, many spores borne in one sporangium.
Procarp, the complex female organ of many Florideæ, consisting of the carpogonium, one or more auxiliary cells, and other accessory cells.
Proliferation, an outgrowth.
Proliferous, bearing outgrowths.
Propagulum (pl. *propagula*), a many-celled body, formed from a vegetative portion of a plant, and specialized for propagation.
Pseudo-, used as a prefix to denote having the appearance of possessing a quality but not possessing it.
Pulvinate, cushion shaped.
Pyramidal, pyramid shaped.

Pyrenoid, a small, definite, rounded, colorless body occurring in a chloroplast and serving as a center of starch accumulation.

Pyriform, pear shaped.

Quadrate, four sided, square.

Racemose, arranged in a cluster of branches along a central axis, the branches becoming of approximately equal lengths and having the older ones below.

Radial, radiating, as from a center.

Ramulus (pl., *ramuli*), a small branch.

Receptacle, the enlarged fruiting portion of the plant, bearing the sunken cavities (conceptacles), in the Fucaceæ.

Reticulate, forming a network.

Rhizoid, a cellular filamentous outgrowth serving as an organ of attachment.

Rhizoidal, pertaining to rhizoids.

Rhizome, a creeping portion of a thallus resembling a horizontal stem and giving off upright stemlike or leaflike branches.

Rimose, having cracks in the surface, as in the old bark of trees.

Rotund, rounded in outline, but a little inclined toward oblong.

Scutellate, shaped like a small platter.

Secund, bearing branches or organs on only one side of an axis.

Septate, bearing septa.

Septum (pl., *septa*), a partition.

Seriate, arranged in series or rows.

Serrate, bearing numerous short, sharp, marginal teeth, like those of a saw.

Serration, the bearing of serrate teeth.

Sessile, borne directly on the axis, not on a stalk.

Setaceous, very slender and rigid, bristlelike.

Silique, the peculiar pod of the mustard family.

Sinus, the more or less acute angle formed by the division of a thallus into approximately equal parts.

Sorus (pl., *sori*), a definite cluster of reproductive organs.

Spatulate, oblong, with the basal end attenuated, like a spatula.

Spermatangium (pl., *spermatangia*), a more or less specialized organ bearing male cells.

Spermatium (pl., *spermatia*), a nonmotile male cell, occurring in the Rhodophyceæ.

Sporangiferous, bearing sporangia.

Sporangium (pl., *sporangia*), a specialized organ bearing spores formed nonsexually.

Spore, a cell specialized for propagation and capable, without fusion with any other cell, of growing into a new plant.

Sporocarp, a fruit produced as a result of the fertilization of the egg in the carpogonium, including the carpospores and the accessory structures, occurring in the Florideæ.

Stellate, star shaped.

Stichidium (pl., *stichidia*), a specialized branch bearing tetrasporangia, occurring in a few Florideæ.

Stipe, the narrow, stemlike stalk by which a flattened thallus is attached.

Stipitate, possessing a stipe.

Stolon, a horizontal, stemlike portion which, attaching itself and becoming separate from the parent, forms a new plant.

Sub-, used as a prefix to denote somewhat, to a limited degree, as subacute; used as a prefix to denote under, as subcortex.

Substratum, the underlying substance on which a plant is growing.

Subulate, *subuliform*, awl shaped, long, slender, and pointed.

Sympodial, having an arrangement where each branch forms a part of the main axis, the resulting axis thus being formed partly from the branches, but resembling a simple axis.

Synonym, an incorrect name used for a species which has a correct name.

Taxonomic, referring to the classification of plants according to their relationships.

Terete, cylindrical and usually tapering, circular in cross section.

Tetrahedral, four sided, used especially with reference to apical cells, and sometimes to tetrasporangia which are triangularly divided.

Tetrasporangium (pl., *tetrasporangia*), a sporangium whose contents are divided into four spores, occurring in the Florideæ and the Dictyotaceæ.

Tetraspore, one of the four spores formed in a tetrasporangium.

Tetrasporic, bearing tetraspores, frequently used with the same meaning as asexual.

Thallus, a plant body not distinctly differentiated into stem and leaf.

Tortuous, bent or twisted in different directions.

Torulose, cylindrical, with swollen portions at intervals, somewhat moniliform.

Triangular, a method of division of a tetrasporangium by four walls formed in different planes and meeting at the center, three of the resulting tetraspores usually being visible on a single surface, each appearing triangular in shape.

Trichoblast, a filamentous, lateral outgrowth consisting of a single row of cells, usually much branched, borne on the surface of a thallus.

Trichogyne, the slender prolongation of the female organ (carpogonium) of the Florideæ with which the male cell fuses as the beginning of fertilization.
Trichome, any hairlike outgrowth from the surface.
Trichothallic, a method of growth in a thallus bearing apical hairs by cell divisions at the bases of the hairs between these and the wider part of the thallus.
Trichotomous, a method of branching by forking into three approximately equal parts.
Truncate, appearing as if cut off at the end.
Turgid, distended by the pressure due to the cell contents.

Undulate, wavy.
Uniaxial, having a single primary axis.
Unilateral, one sided, borne on or turned to one side.
Unilocular, a term used for the sporangia of many Phæophyceæ which are not divided into separate compartments, but produce numerous motile spores in the single cavity of the sporangium.
Unisexual, bearing the organs of only one sex on a single individual.
Urceolate, pitcherlike.

Vacuole, a cavity in the living material of cells, containing a clear, watery solution, the cell sap.
Ventral, referring to the lower, or front, surface of a dorsiventral structure.
Verrucose, appearing as if having warts, warty.
Verticillate, arranged in a whorl of similar parts around an axis.
Vesicle, a small, bladderlike structure or cavity.
Vesicular, possessing vesicles.
Virgate, long, slender, and unbranched, wand shaped.

Zonate, a method of division of a tetrasporangium by three walls in the same plane, all four resulting tetraspores being visible from the surface, lying in a single row.
Zonation, the superficial marking of a thallus by concentric lines.
Zoospore, a motile spore.
Zygote, the cell formed by the fusion of two sexual cells.

EXPLANATION OF PLATES.

PLATE LXXXIV: 1. *Cladophora crystallina*×1/1. 2. *Udotea cyathiformis*×1 1/10. 3. *Udotea cyathiformis*×4/5 circ. 4. *Bryopsis plumosa*×60/67.

PLATE LXXXV: 1. *Codium tomentosum*×1/6. 2. *Codium decorticatum*×8/27 circ.

PLATE LXXXVI: 1. *Petalonia fascia*×37/50 circ. 2. *Rosenvingea orientalis*×3/8 circ.

PLATE LXXXVII: 1. *Castagnea zosteræ*×71/100. 2. *Stilophora rhizodes*×13/35 circ.

PLATE LXXXVIII: 1 and 2. *Leathesia difformis*×1/1 circ. 3. *Sporochnus pedunculatus*×1/1.

PLATE LXXXIX: *Fucus vesiculosus*×2/5.

PLATE XC: 1. *Sargassum natans*×1/4 circ. 2. *Sargassum filipendula*×1/3 circ.

PLATE XCI: 1. *Zonaria flava*, bearing *Spermothamnion investiens*×2/3 circ. 2. *Zonaria variegata*×5/8 circ.

PLATE XCII: 1. *Padina vickersiæ* (type)×1/4 circ. 2. *Padina vickersiæ*×1/2.

PLATE XCIII: 1. *Spatoglossum schrœderi*×1/3 circ. 2. *Dictyopteris polypodiodes*×1/3 circ. 3. *Dictyopteris serrata*×2/5 circ.

PLATE XCIV: 1. *Dictyota dichotoma*, usual form from Fort Macon jetty, *a*, male; *b*, female×2/5. 2. *a* and *b*, *Spatoglossum schrœderi*×38/87; *c* and *d*, *Dictyota dichotoma*, narrow form from coral reef×38/87. 3. *Dictyota dichotoma*, male, bearing proliferations from apices×1/3.

PLATE XCV: 1. *Gelidium coerulescens*×3/5 circ. 2. *Gelidium crinale*×1 3/5. 3. *Gymnogongrus griffithsiæ*×1/2 circ.

PLATE XCVI: 1. *Agardhiella tenera*, usual form×15/29. 2. *Agardhiella tenera*, slender form from coral reef×1/3 circ.

PLATE XCVII: 1. *Meristotheca duchassaingii; a*, cystocarpic; *b*, tetrasporic, bearing *Streblonema invisibile*×11/28 circ. 2. *Meristotheca duchassingii*×11/36 circ.

PLATE XCVIII: 1. *Rhabdonia ramosissima*×9/16 circ. 2. *Eucheuma gelidium*×2/7 circ.

PLATE XCIX: 1. *Gracilaria confervoides*, cystocarpic×2/5 circ. 2. *Gracilaria multipartita*, from harbor; *a* and *b*, sterile; *c*, cystocarpic×16/35 circ.

PLATE C: 1. *Hypnea musciformis*, type 1, tetrasporic×2/5 circ. 2. *Hypnea musciformis*, type 2, cystocarpic×2/5 circ.

PLATE CI: 1. *Hypnea musciformis*, type 3, cystocarpic×9/26. 2. *Hypnea musciformis*, winter condition ×4/5. 3. *Rhodymenia palmetta*×25/39. 4. *Rhodymenia palmetta*×9/28 circ.

PLATE CII: 1. *Agardhinula browneæ*, cystocarpic×7/12. 2. *Chrysymenia agardhii*×1/2.

PLATE CIII: 1. *Chrysymenia enteromorpha*, from Bogue Beach×1/2 circ. 2. *Chrysymenia enteromorpha* from coral reef×2/5 circ.

PLATE CIV: 1. *Chrysymenia uvaria*×7/12 circ. 2. *Lomentaria uncinata*×3/4. 3. *Lomentaria rosea*×1/3 circ. 4. *Champia parvula*×6/7.

PLATE CV: *Nitophyllum medium;* 1. Sterile, densely branched×3/7 circ. 2. Type, veins evident, tetrasporangial sori in rather irregular lines×1/3 circ. 3. Veins conspicuous, tetrasporangial sori in unusually regular lines or very irregular×3/7 circ.

PLATE CVI: 1. *Grinnellia americana*, tetrasporic×3/7 circ. 2. *Laurencia tuberculosa* var. *gemmifera*×3/5 circ.

PLATE CVII: 1. *Chondria littoralis*×1/3 circ. 2. *Chondria dasyphylla*, winter condition×1/1. 3. *Chondria tenuissima* var. *baileyana*×5/8. 4. *Chondria dasyphylla*×3/8 circ.

PLATE CVIII: 1. *Chondria sedifolia*, cystocarpic×3/5 circ. 2. *Chondria sedifolia*, tetrasporic×9/20 circ. 3. *Polysiphonia havanensis*×7/15. 4. *a* and *b*, *Polysiphonia denudata; c*, *Polysiphonia harveyi*×10/11.

PLATE CIX: 1. *Polysiphonia denudata*×4/11 circ. 2. *Polysiphonia denudata*×14/17. 3. *Polysiphonia nigrescens*×15/16. 4. *Brongniartella mucronata*×19/30.

PLATE CX: 1. *Herposiphonia tenella* on *Gracilaria multipartita*×1/2. 2. *Dasya pedicellata*×29/56.

PLATE CXI: 1. *Spyridia filamentosa*×10/21. 2. *Ceramium rubrum*×1/2 circ. 3. *Ceramium strictum*×7/15.

PLATE CXII: 1. *Halymenia decipiens*×1/3 circ. 2. *Halymenia floresia*×1/2 circ. 3. *Halymenia gelinaria* ×3/5. 4. *a*, *Halymenia gelinaria*×3/7 circ.; *b*, *Halymenia floridana*×3/7 circ.; *c*, *Amphiroa fragilissima*×3/7 circ. 5. Undetermined species, No. 1×9/16.

PLATE CXIII: 1. *Grateloupia filicina*×5/14 circ. 2. *Grateloupia gibbesii*×1/3 circ. 3. *Cryptonemia crenulata*×6/11. 4 and 5. *Corallina cubensis*. 4. ×1/1. 5. ×1 1/3.

PLATE CXIV: 1, 2, and 3. *Padina vickersiæ;* 1, cross section of thallus and oogonial sorus, oogonia almost mature; 2, cross section of thallus and tetrasporangial sorus, showing undivided tetrasporangia; 3, cross section of thallus and antheridial sorus, antheridia almost mature×272. 4. *Nitophyllum medium*, type, cross section of thallus showing, below, edge of soral thickening composed of three cell layers, three veins shown cut across; the central one has adjoining portion of thallus three cells deep with irregular thickenings on walls×272. 5. *Nitophyllum medium*, cross section of tetrasporangial sorus, showing soral thickening, undivided tetrasporangia, and veins×272. 6. *Corallina capillacea*×50.

PLATE CXV: 1 to 9. *Phæostroma pusillum;* 1, margin of thallus, showing separate creeping filaments, plurilocular sporangia, hair, etc.×245; 2, enlarged detail, showing immature plurilocular sporangium, chromatophores, etc.×1040; 3, mature plurilocular sporangium in obliquely longitudinal view×670; 4, mature plurilocular sporangium viewed from above (end view)×670; 5, margin of thallus (more compact than that shown in fig. 1), with unilocular sporangia, a sorus at *a* and the beginning of a sorus at *b*×245; 6, enlarged detail of thallus, showing chromatophores and unilocular sporangia as seen from above×1040; 7, young unilocular sporangium viewed from above×1040; 8, the beginning of a sorus viewed from above×1040; 9, a mature sorus of unilocular sporangia viewed from above×1040. 10 to 16. *Derbesia turbinata;* 10, apex of thallus showing a young lateral branch×81; 11, lateral or unequal dichotomous branching×81; 12, dichotomous branching×81; 13 to 16, usual forms of sporangia×162, 13 and 15 showing pedicel cells. Drawings by M. A. Howe, from Howe and Hoyt, 1916.

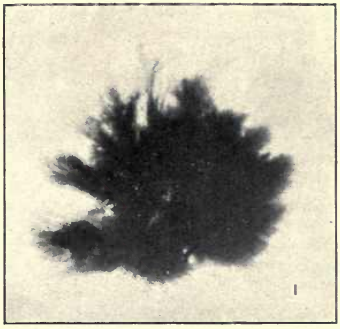
PLATE CXVI: 1. *Erythrocladia recondita* on *Dictyota dichotoma*, photograph made after staining with iodine, showing habit of plant and sporocarps (the larger darker cells)×160. 2. *Erythrocladia vagabunda* on *Dictyota dichotoma*, photograph made after staining with iodine, showing habit of plant and sporocarps (some of the larger cells)×160, a small colony of *E. recondita* with smaller darker cells shown near *B* at the lower right-hand corner. From Howe and Hoyt, 1916.

PLATE CXVII: 1 to 5. *Erythrocladia recondita;* 1, portion of thallus near margin viewed from above, showing outlines of protoplasts and of pyrenoids with outlines of the cortical cells of its host×670; 2 and 3, portions of cross sections of endophyte and its host, showing the immersed vegetative cells and the more or less exserted spermatia (spm.)×670; 4, portion of a cross section showing a carpogonium with exserted trichogyne×670; 5, portion of pseudoparenchymatous thallus viewed from above, showing protoplasts of vegetative cells, spermatia (spm), carpogonium (cpg), and sporocarps (spcp)×670. 6 to 11. *Erythrocladia vagabunda;* 6, portion of thallus viewed from above, showing outlines of protoplasts and of pyrenoids with outlines of the cortical cells of its host×415; 7, portion of thallus showing three vegetative cells, six sporocarps (spcp), and five cavities from which carpospores have been discharged×670; 8 to 9, portions of thalli showing vegetative cells and sporocarps (spcp)×415; 10, a single carpospore lying on the surface of its host, in the outer walls of which it is already partially immersed×670; 11, a young filament (four-celled stage) viewed from above×415. 12 to 17. *Microchæte nana;* 12, a young filament, prostrate, but beginning to turn upward at apex, thickness of sheath slightly exaggerated×670; 13, older and normally curved filament showing two basal heterocysts (not common), thickness of sheath slightly exaggerated×670; 14, an unusually straight, apparently mature filament×245; 15, filament showing curve of a frequent form×245; 16 and 17, apex and base of filament shown in fig. 15 ×670. Drawings by M. A. Howe, from Howe and Hoyt, 1916.

PLATE CXVIII: *Acrochætium infestans;* 1. Filaments of the usual form in the wall of a hydroid, with two exserted filaments, only the protoplasts being shown in the immersed portions, since the cell walls are almost invisible×670. 2. An exserted sporangium sessile on an interior filament×670. 3. An exserted filament of three cells, one being a sporangium and another probably an immature sporangium×670. 4. An exterior filament with short branches, short hairs, and a single lateral sporangium×670. 5. A single typical cell of an interior filament showing chromatophore, pyrenoid, etc.×1040. 6. Exterior filaments showing sporangia in terminal clusters and a single lateral

sporangium×670. 7. Short exterior filaments×670. 8. A branched exterior filament showing lateral and terminal sporangia (one of the emptied lateral sporangia is apparently being refilled or regenerated from the supporting vegetative cell)×670. 9. A short exterior filament showing regeneration of a terminal sporangium×670. 10. Part of a plant showing mode of branching and tortuous course of a part of an interior filament, etc.×670. 11. A short exterior filament bearing immature and emptied sporangia×670. 12. An unusually long exterior filament showing long hairs and short secund branchlets (solitary or in pairs)×670. Drawings by M. A. Howe, from Howe and Hoyt, 1916.

PLATE CXIX: *Acrochætium affine;* 1. Spore attached to margin of the *Dictyota* thallus×415. 2. A spore that has developed a small accessory prostrate basal cell and is also beginning to send up an erect filament×415. 3. Base of a mature plant showing simple basal cell and two erect filaments, each of which branches from its lowest cell×415. 4. Base of a similar, though larger, plant with four primary erect filaments, each branched at its base, a small cystocarp shown at *a* ×415. 5. Base of a plant showing a scarcely enlarged basal cell, short creeping basal filaments, and a single erect filament which has two branches from its lowest cell×415. 6. A vertical section through the base of a plant, showing a few small accessory cells that partly cover the primary basal cell×415. 7. Base of a plant showing accessory basal cells and three coarse and three slender erect filaments, none of which branches from its lowest cell×415. 8. Base of a plant with accessory basal cells and erect filaments of various sizes×415. 9. Base of a plant that has developed a small imperfect basal disk, with the original spore still evident×415. 10. Optical section of the margin of the Dictyota thallus showing base of a young plant with a single immersed basal cell and a single erect filament×415. 11. Optical section of the base of a plant showing subpyriform semi-immersed primary basal cell and several superficial smaller secondary cells, some of which send up erect filaments×415. 12. Section through the margin of the Dictyota thallus showing single subpyriform basal cell with penetrating foot×415. 13. Base of a detached plant showing primary basal cell, its penetrating foot, three erect filaments, and two small accessory basal cells×415. 14. Section of margin of the Dictyota thallus showing four basal cells of approximately equal size that are more or less immersed×415. 15. A sporangium terminal on a main branch×415. 16. Sessile lateral sporangia×415. 17. A sporangium on a one-celled pedicel×415. 18. Procarp and antheridia×670. 19. An older procarp with no antheridia apparent in its vicinity×670. 20. A cystocarp×670. 21. A typical cell from one of the coarser filaments×670. 22. A typical cell from one of the more slender filaments×670. Drawings by M. A. Howe, from Howe and Hoyt, 1916.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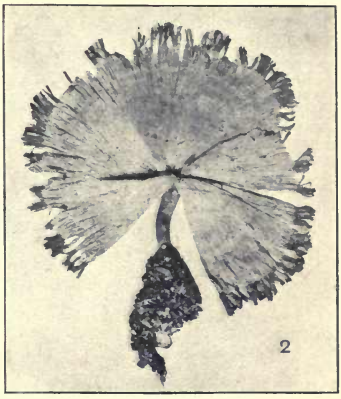
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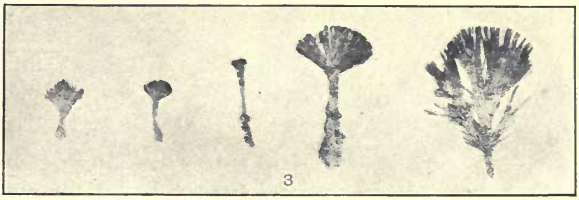
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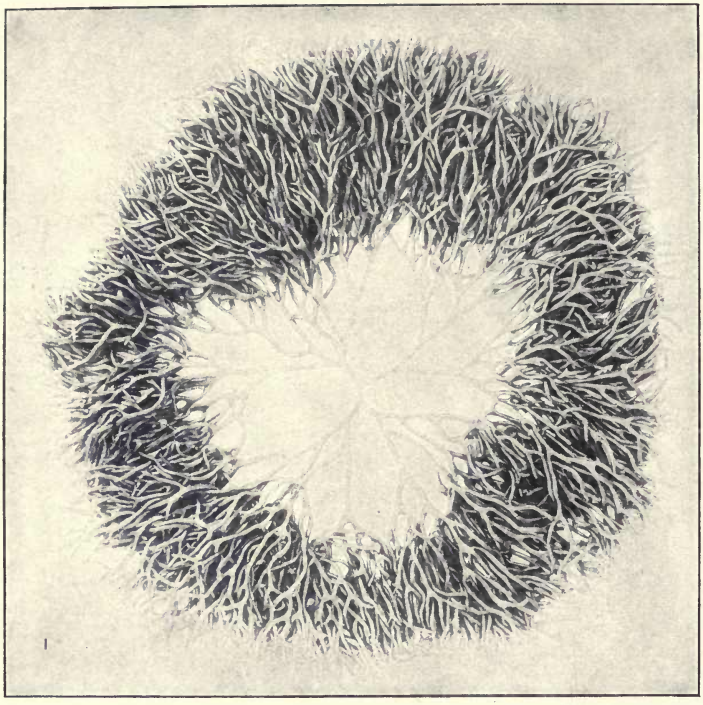
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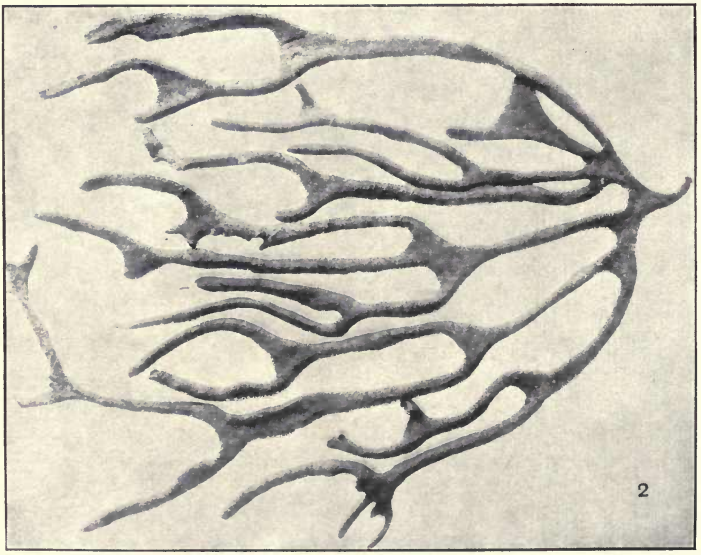
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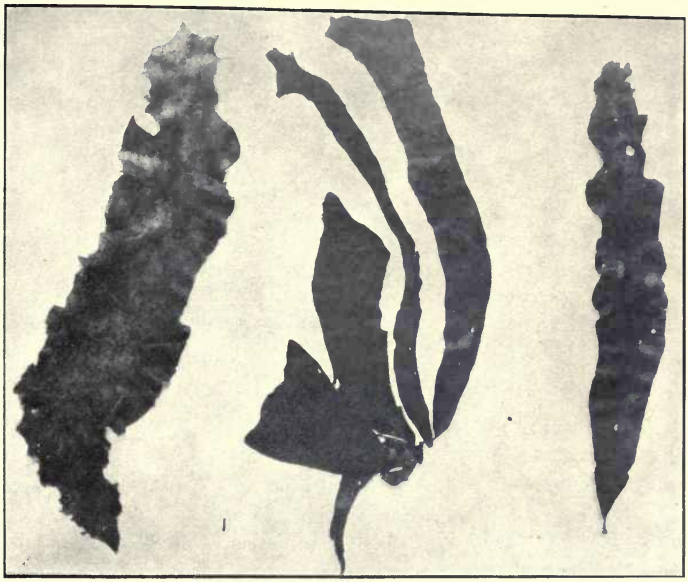

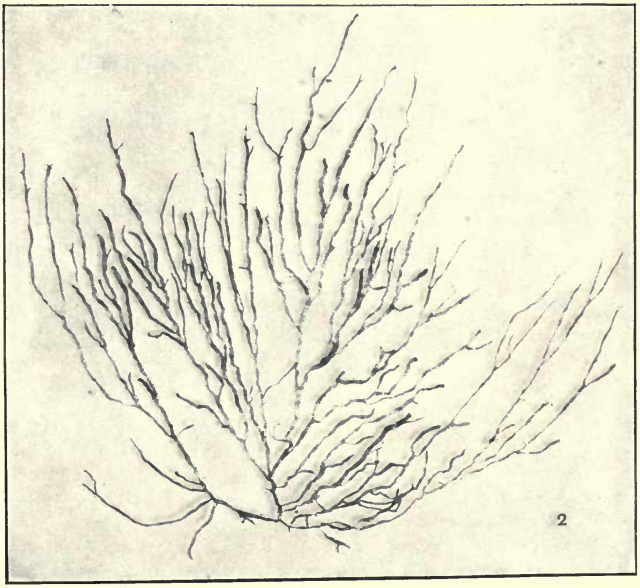

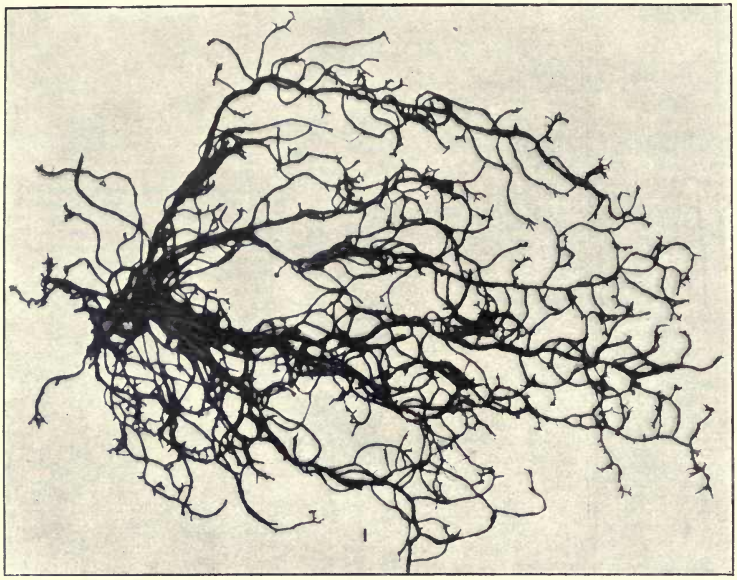

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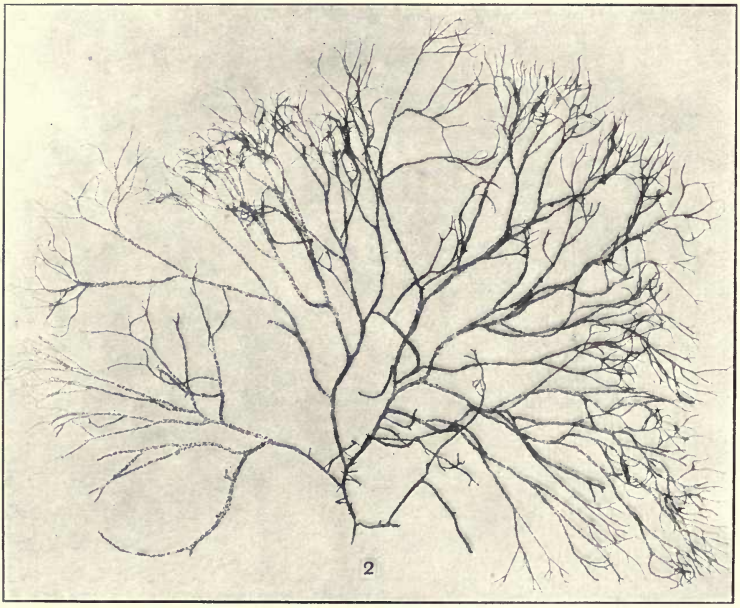

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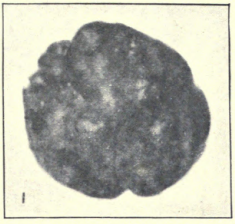
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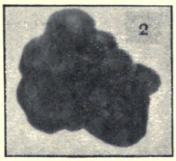
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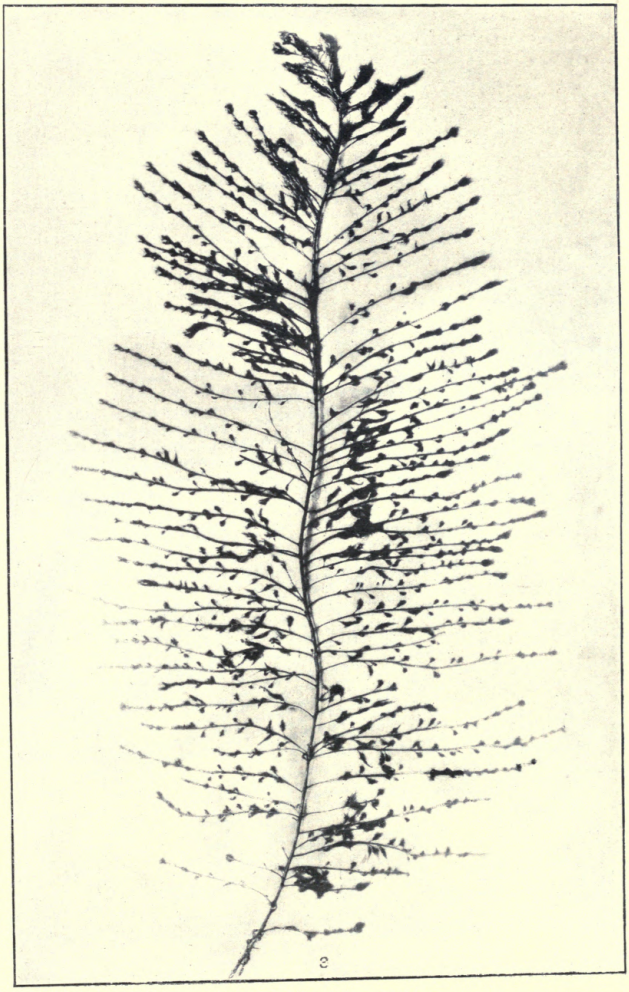
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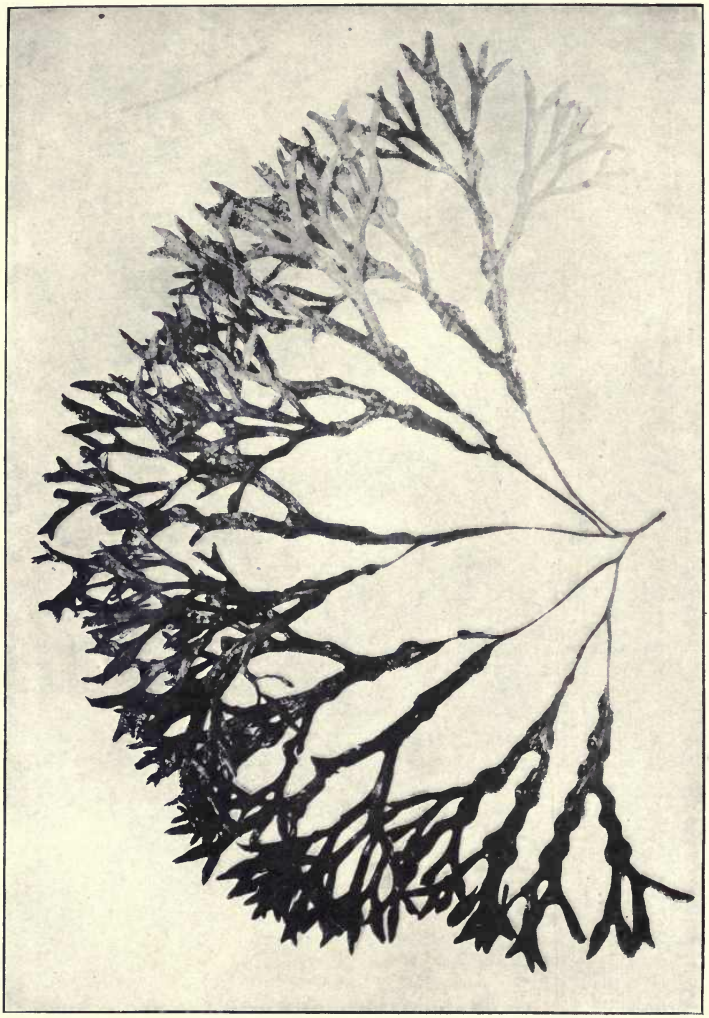

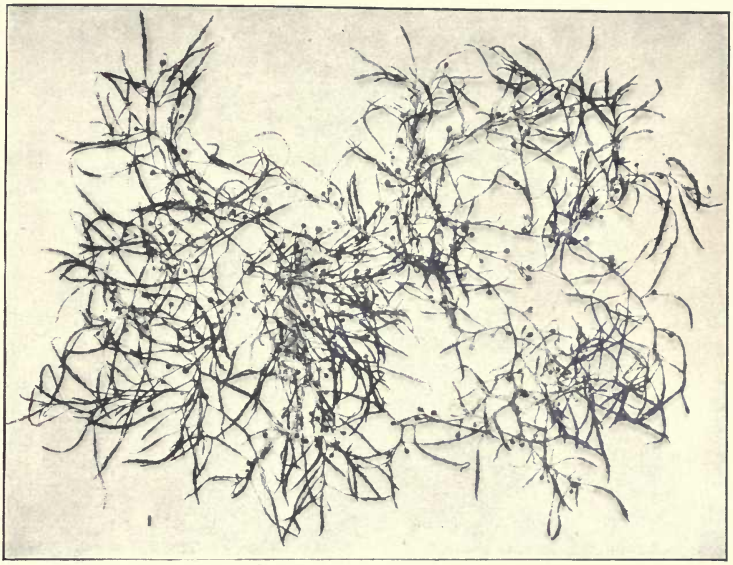

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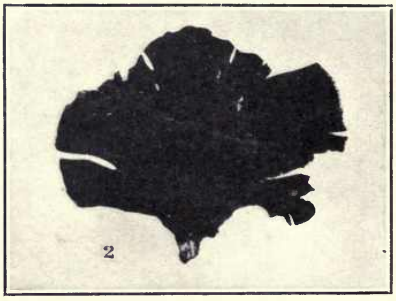
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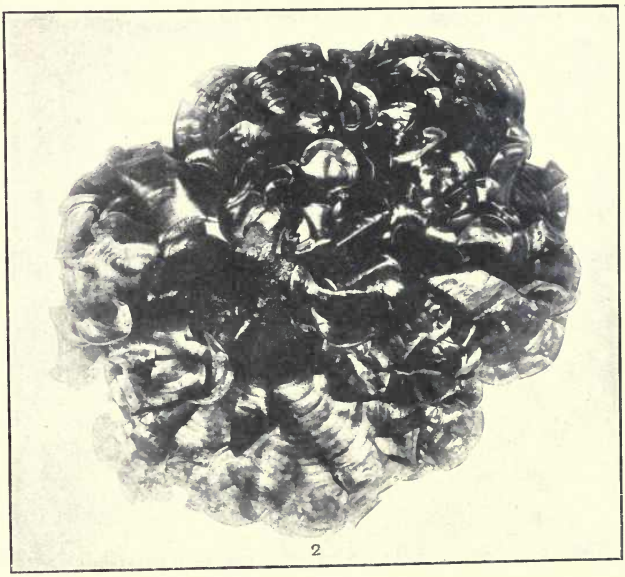

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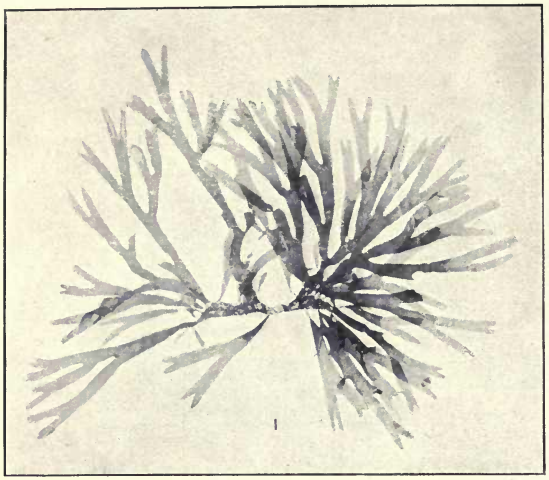
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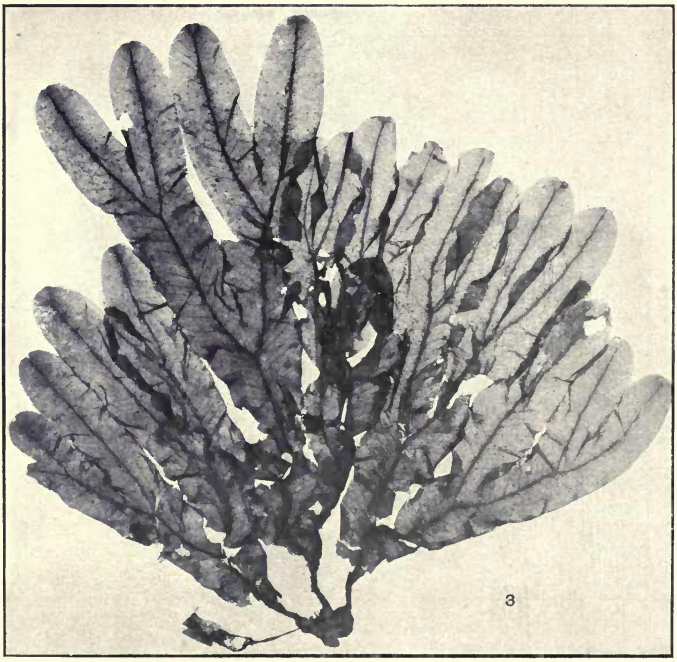
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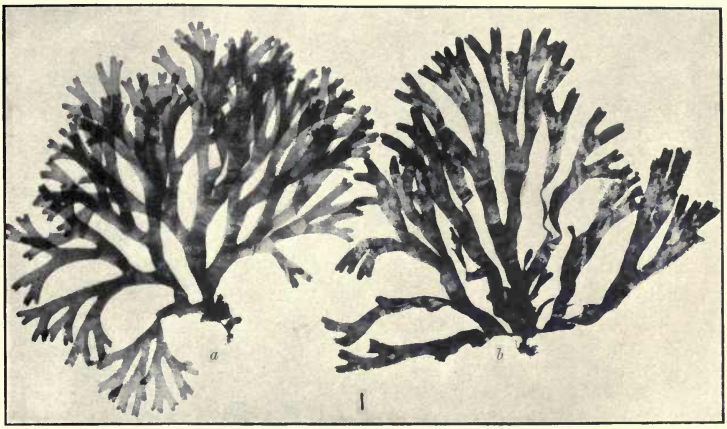
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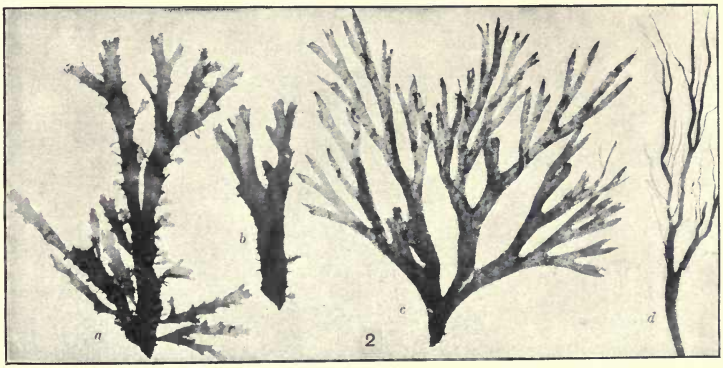
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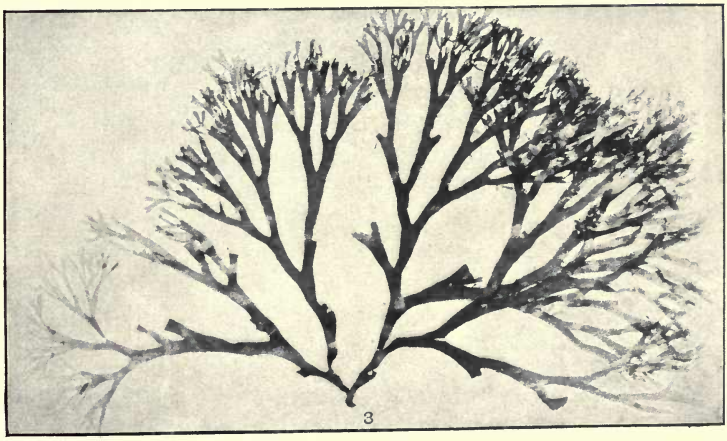
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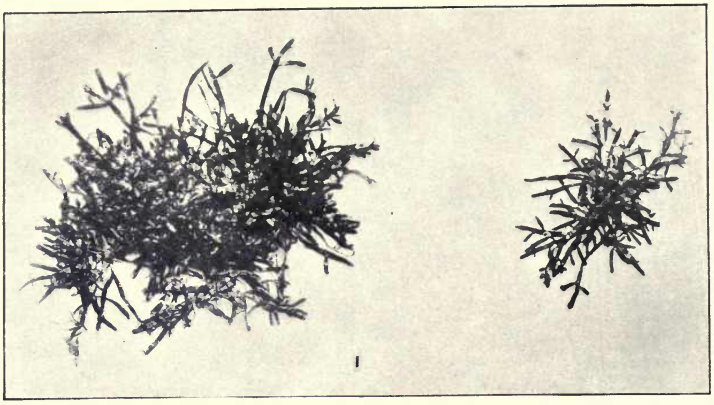

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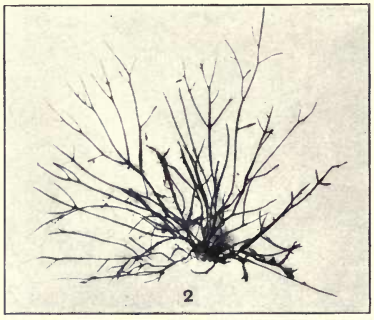

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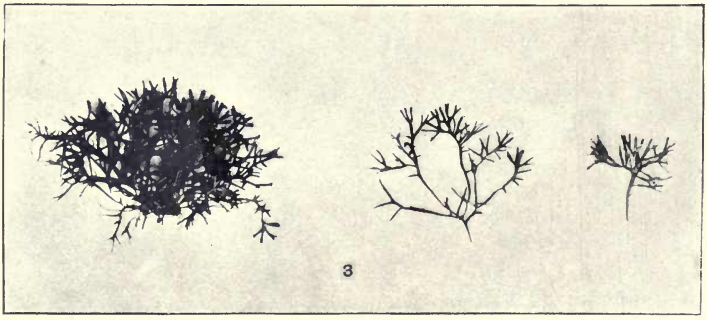

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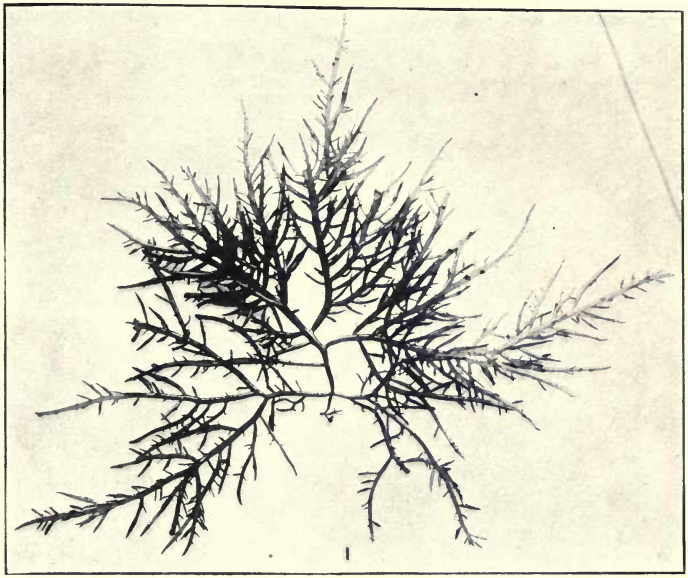

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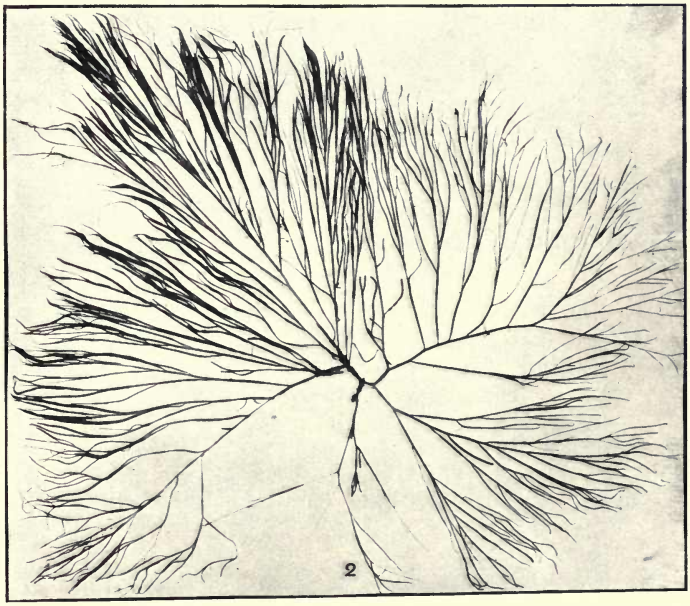

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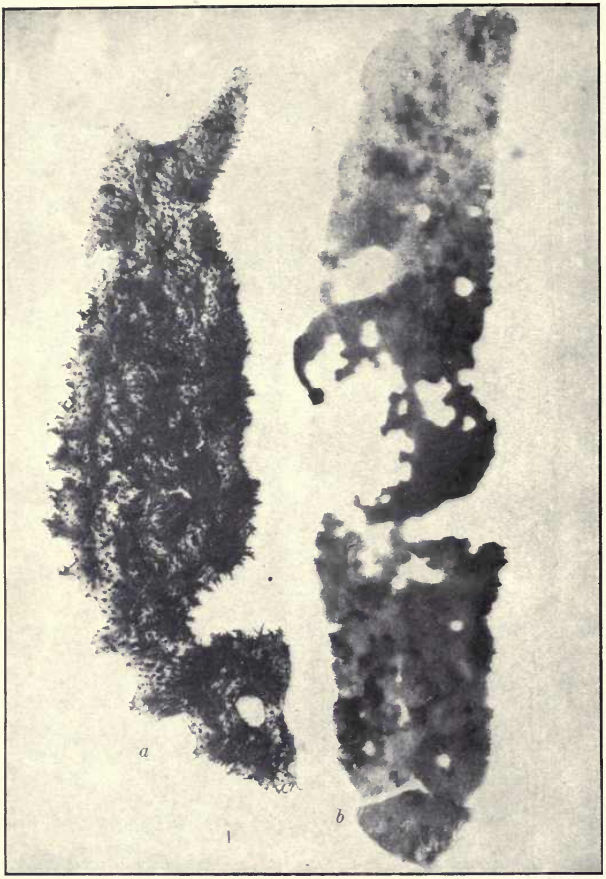
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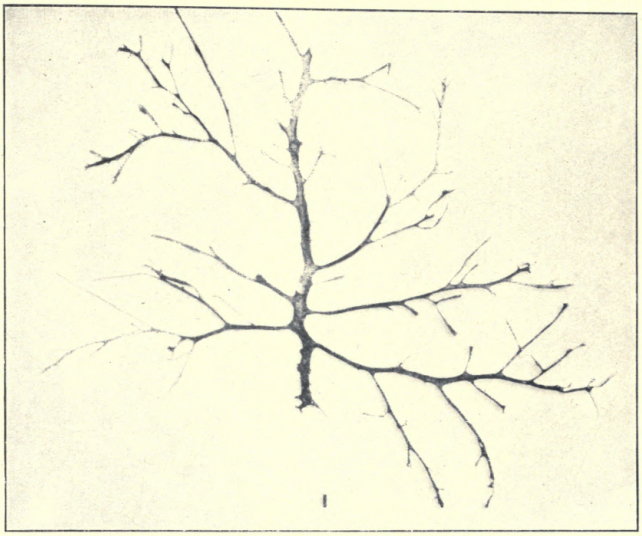

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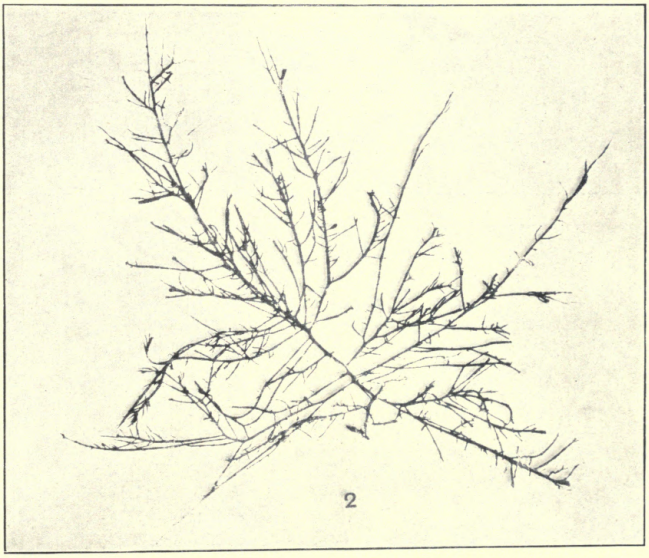

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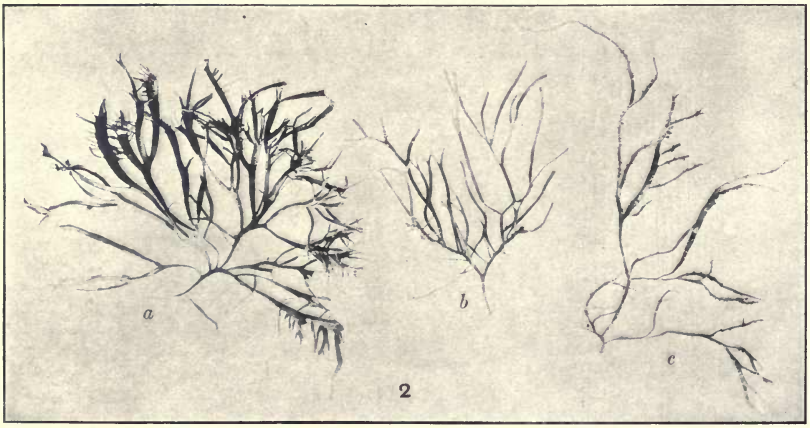

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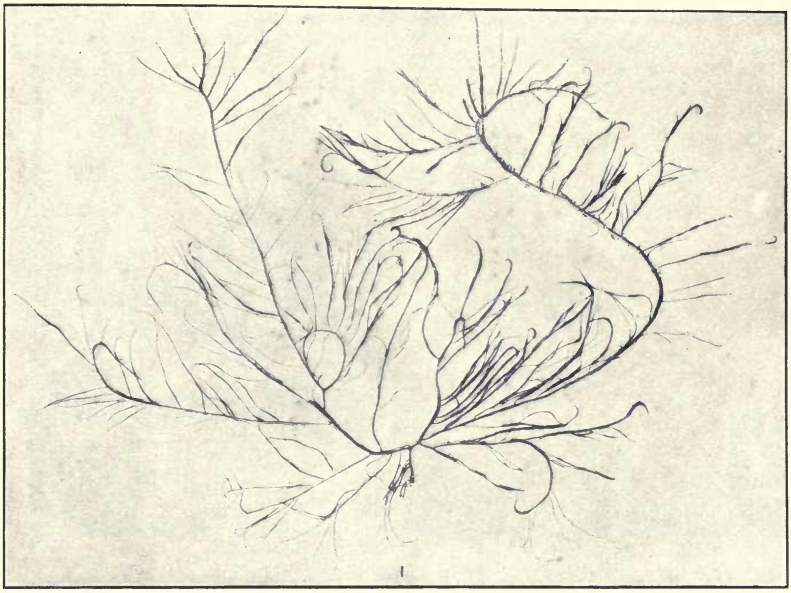

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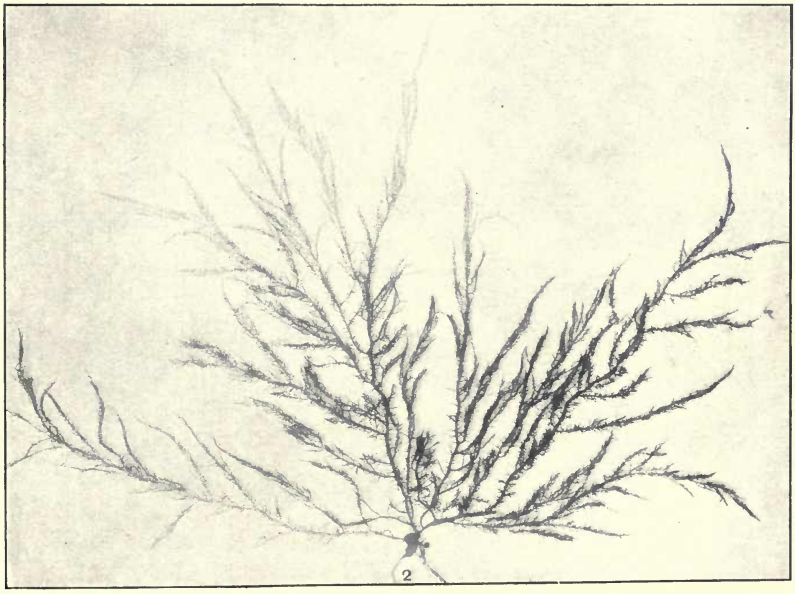

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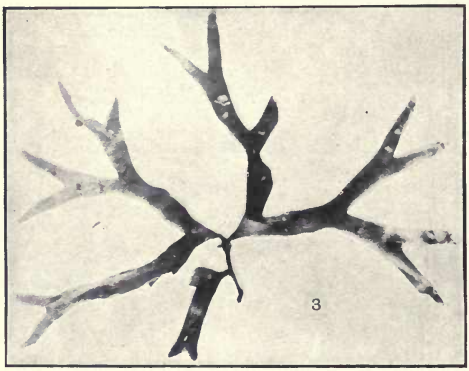

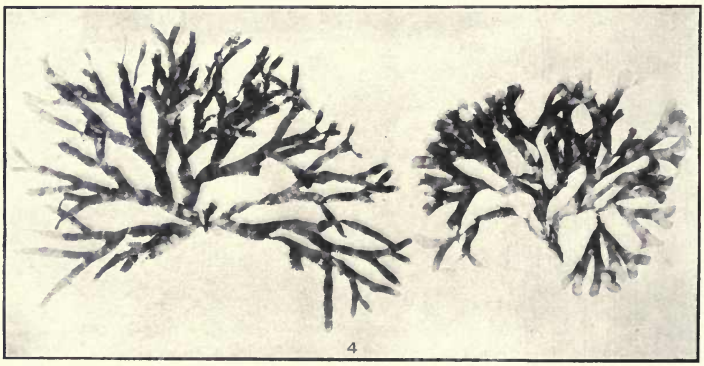

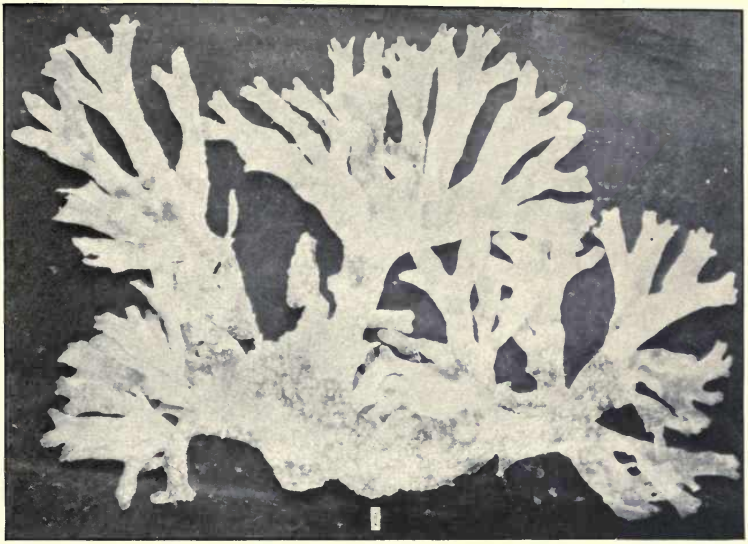

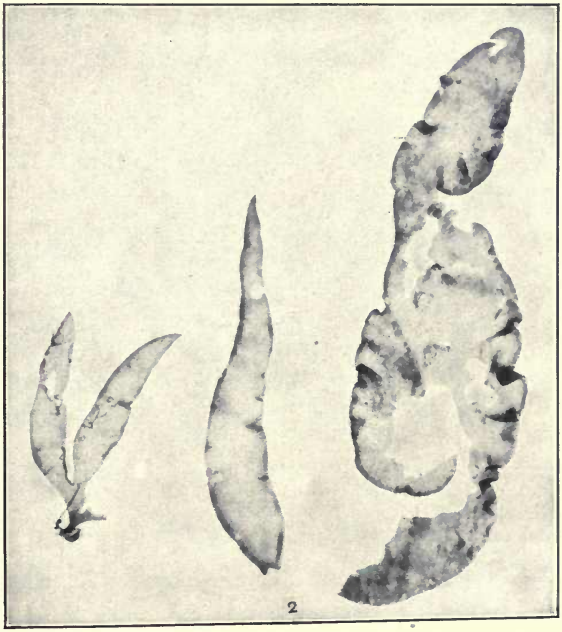

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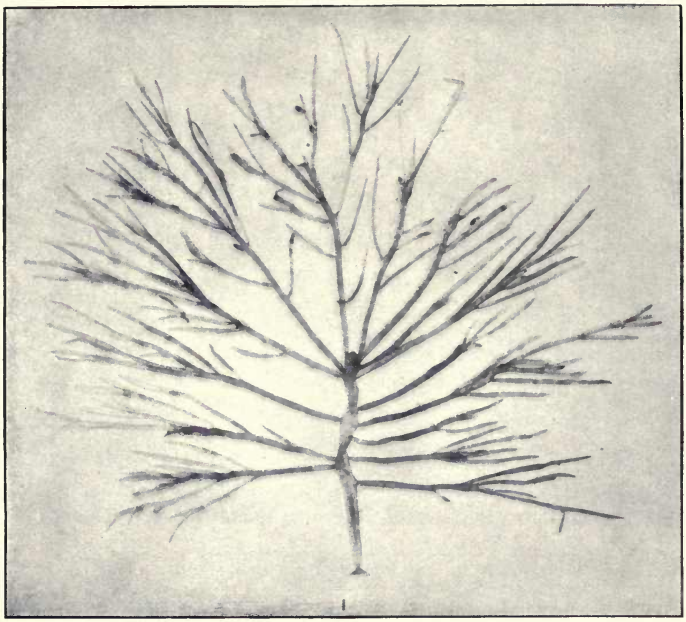

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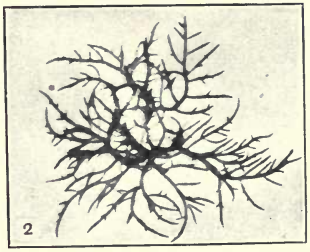
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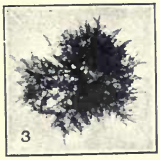
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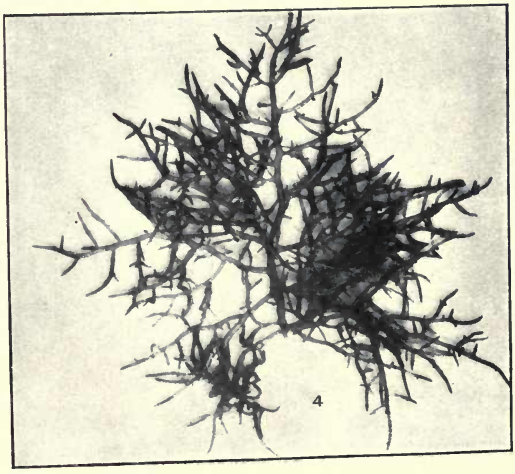
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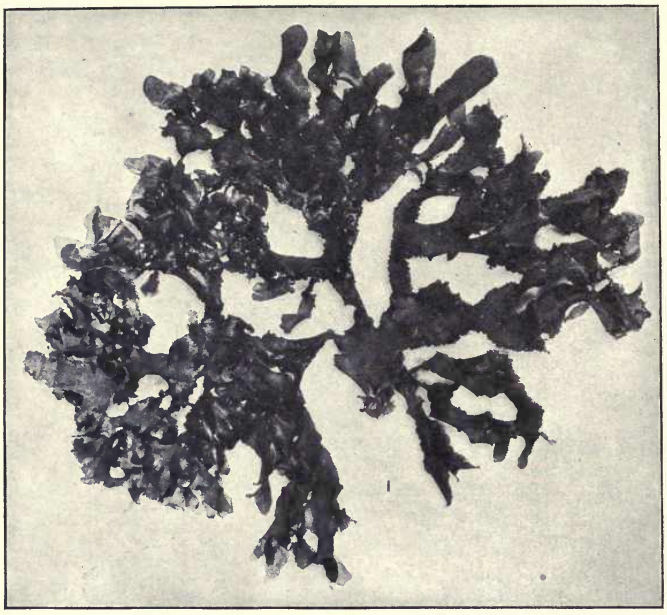

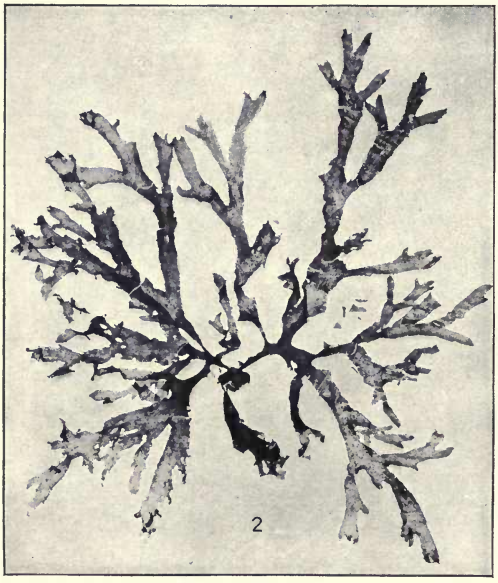
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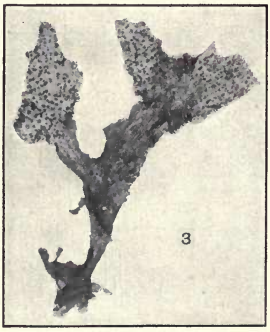
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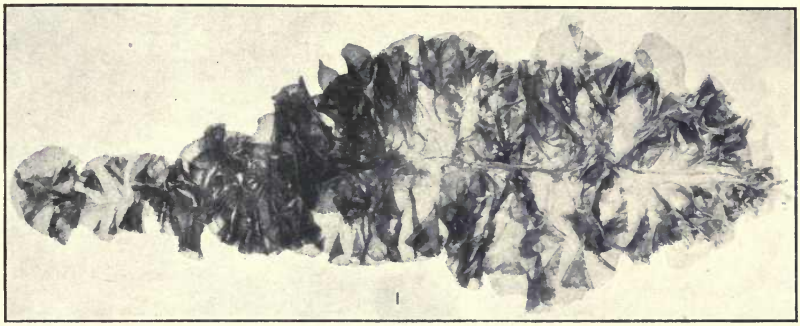

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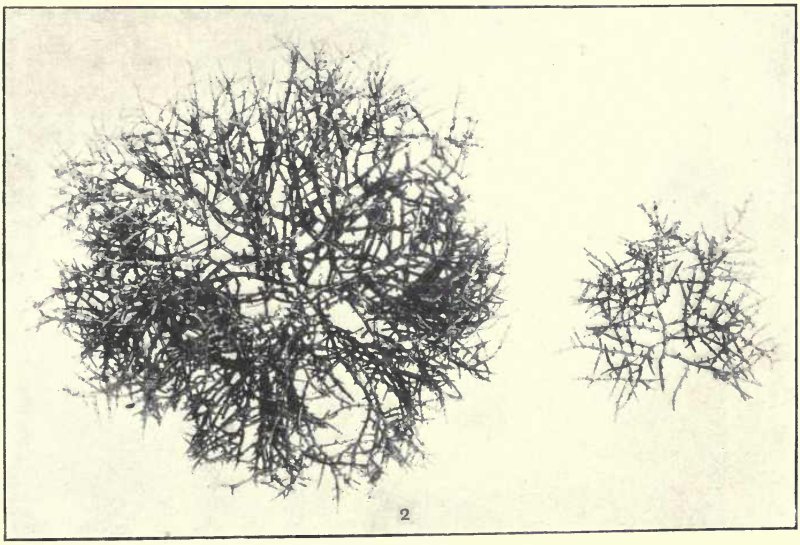

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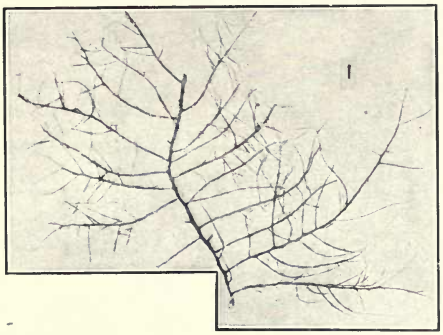
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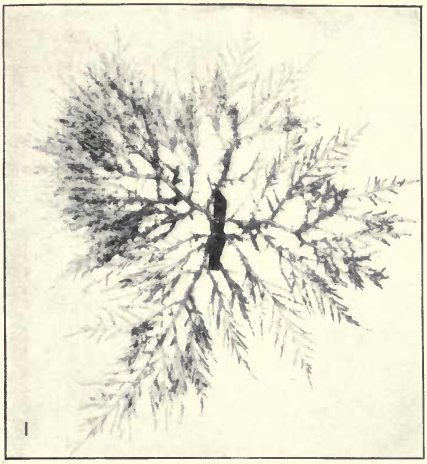
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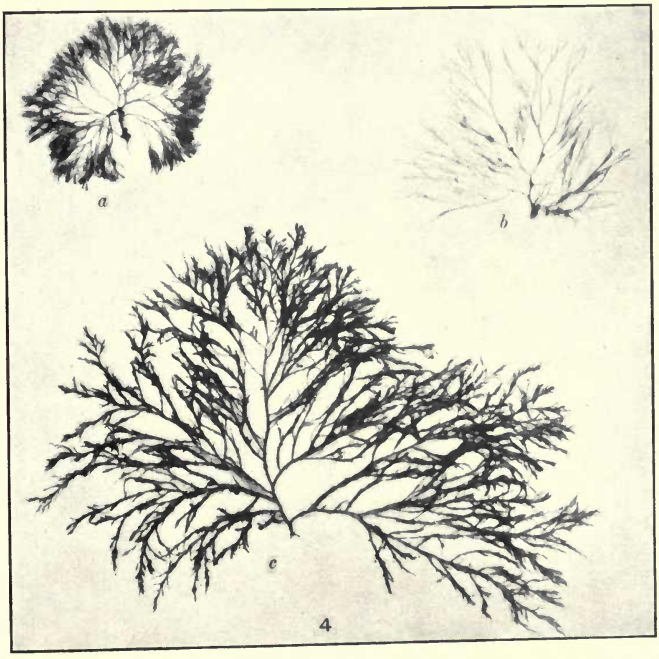
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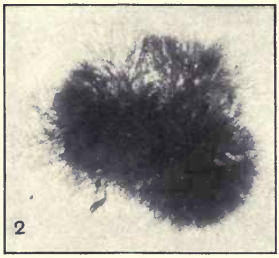
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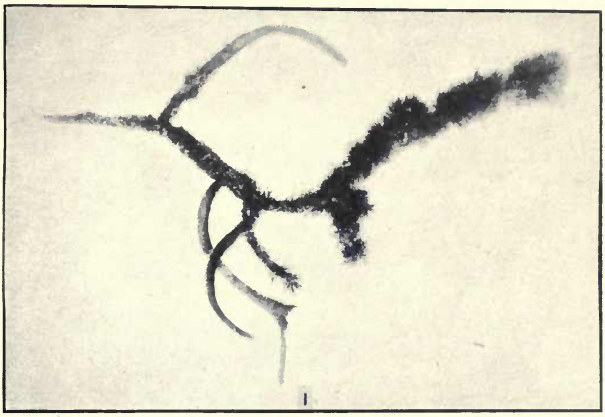

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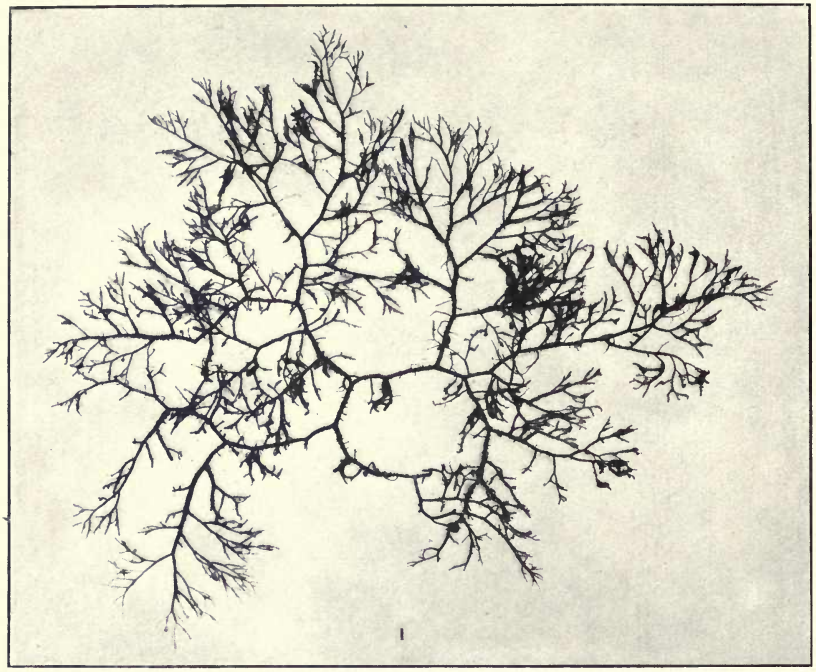
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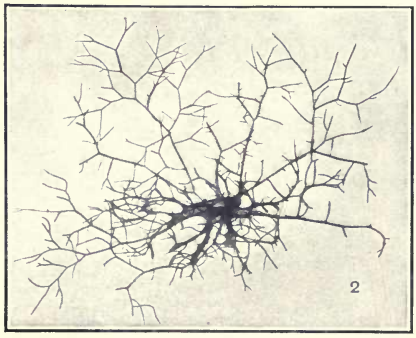
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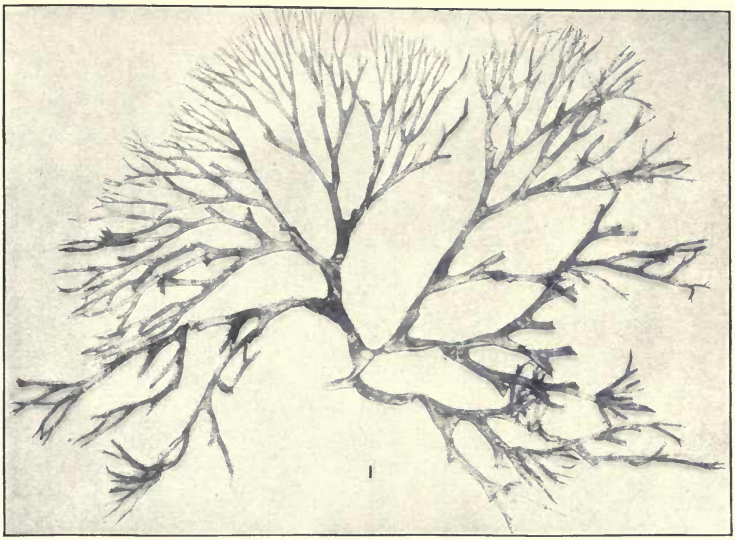
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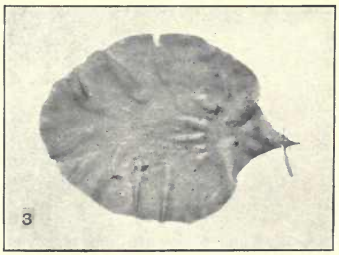
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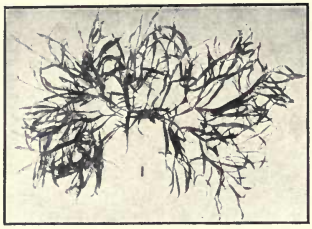

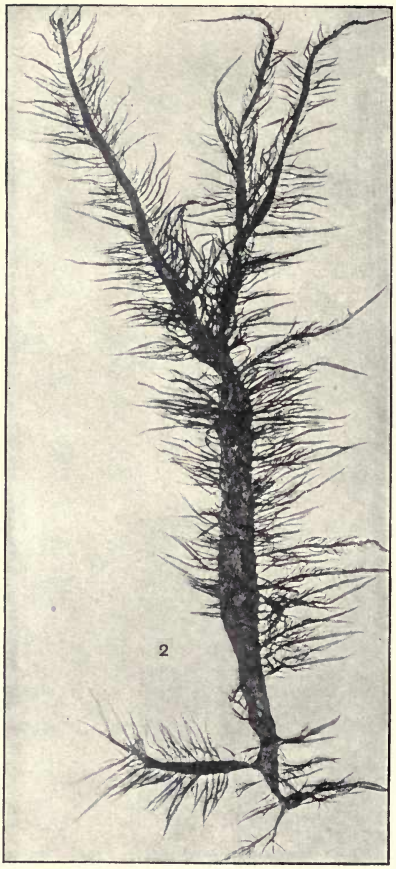
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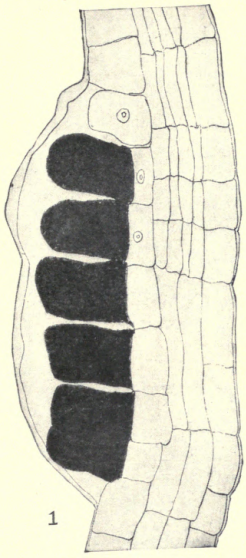

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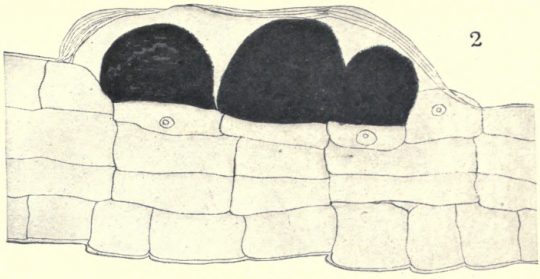

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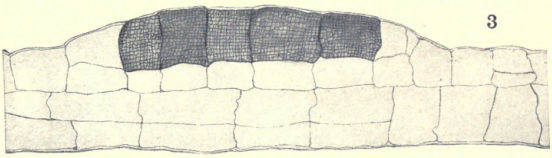

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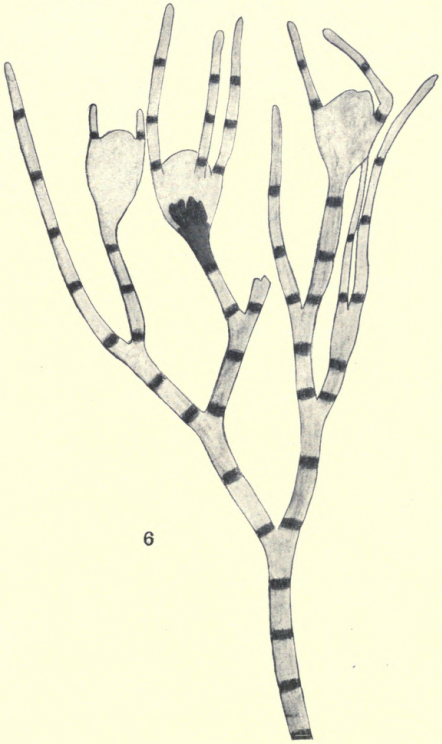

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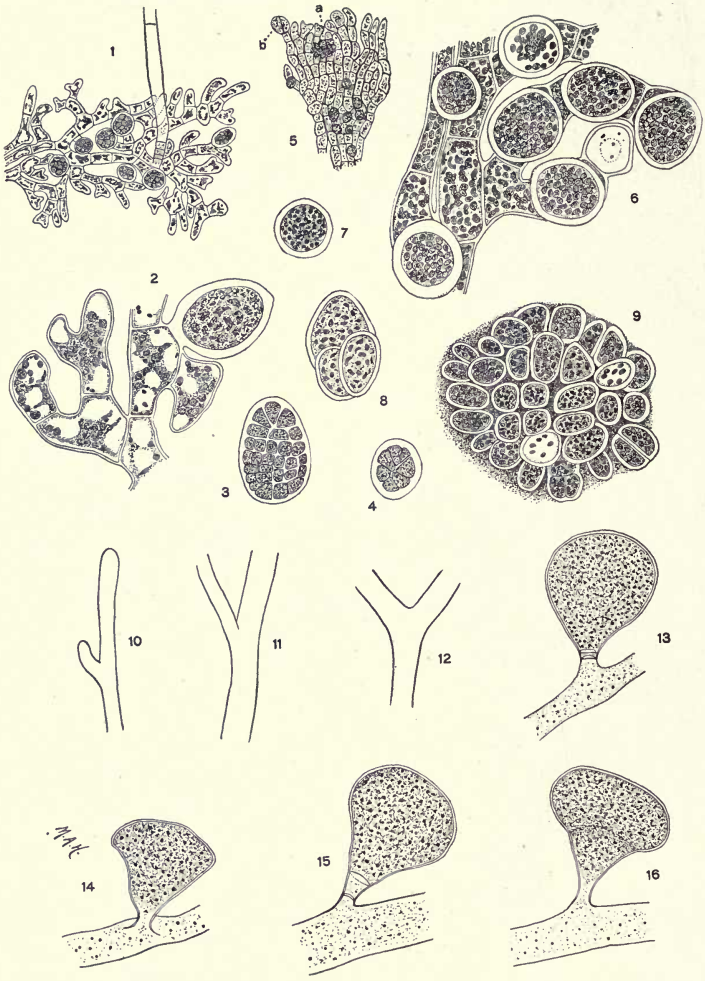
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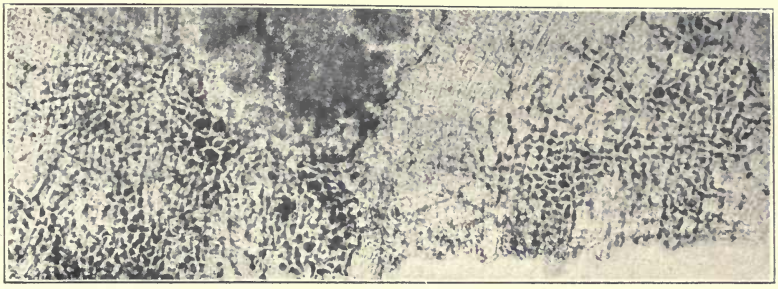

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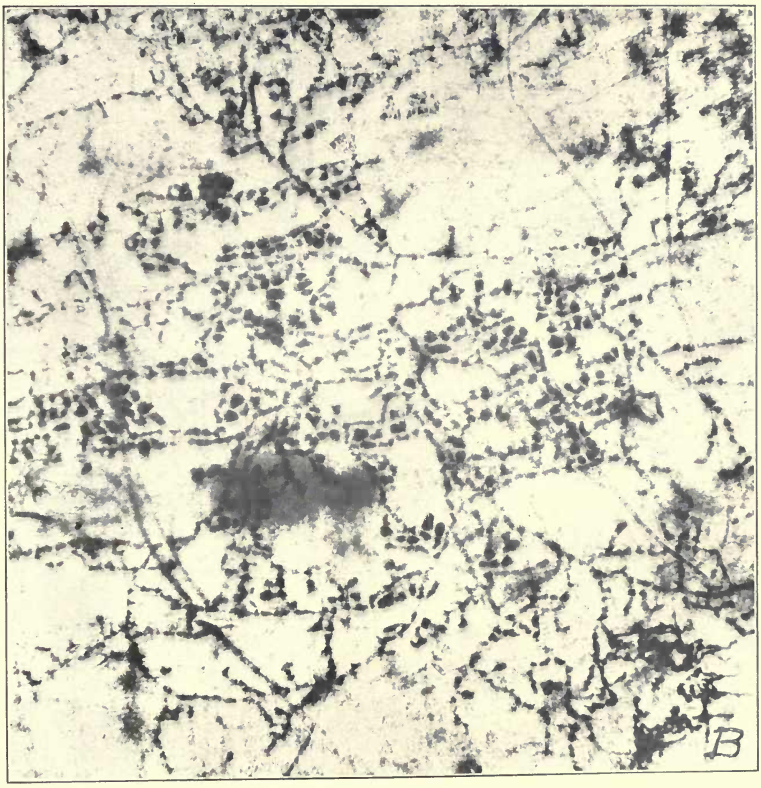

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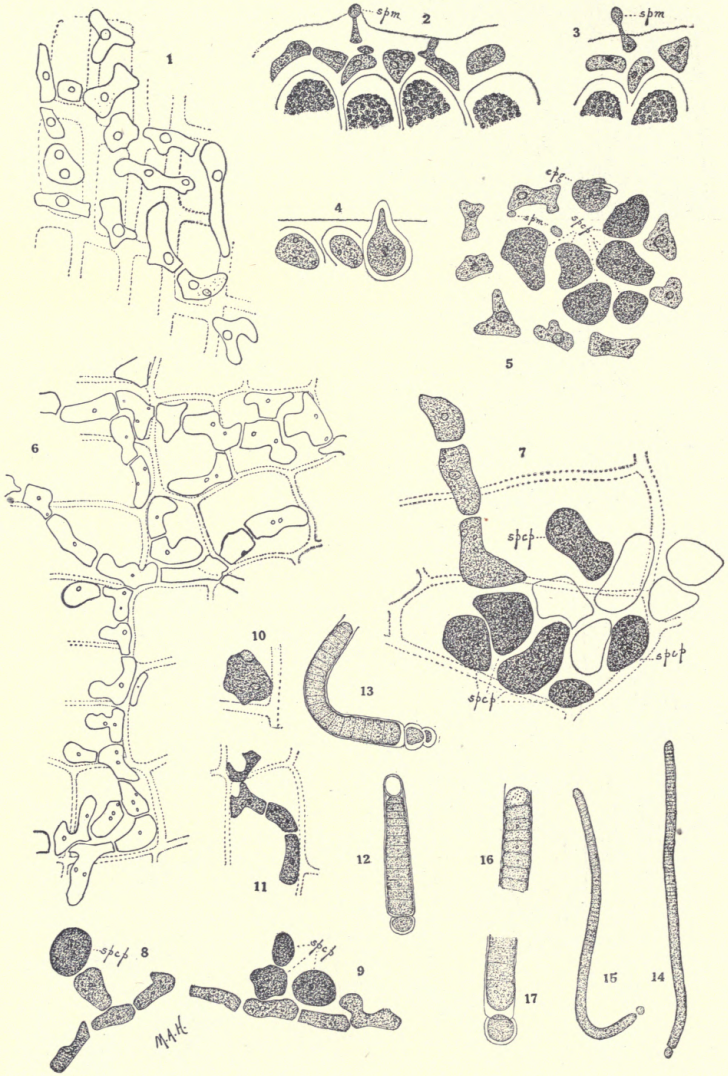
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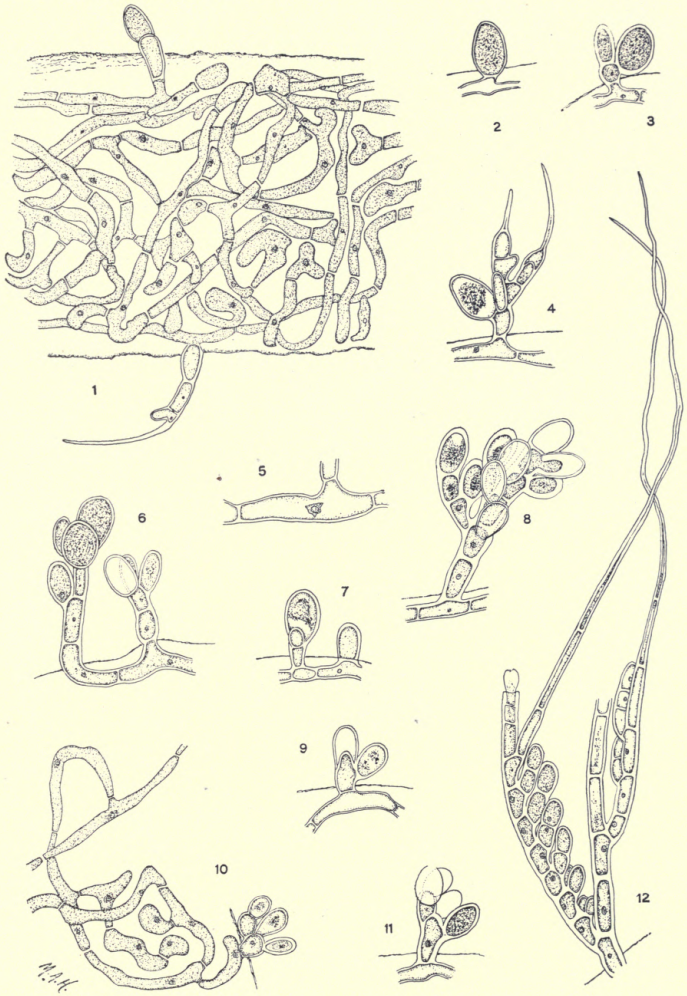
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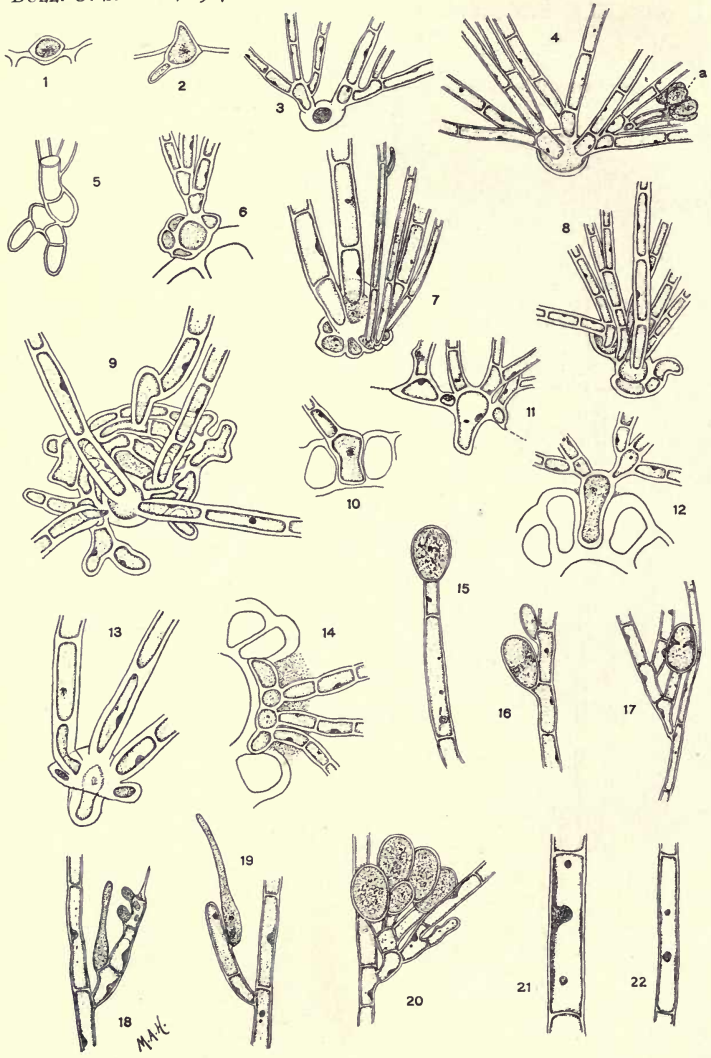
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